JULY 1950

Journal

VOL. 42 • NO. 7

AMERICAN WATER WORKS ASSOCIATION

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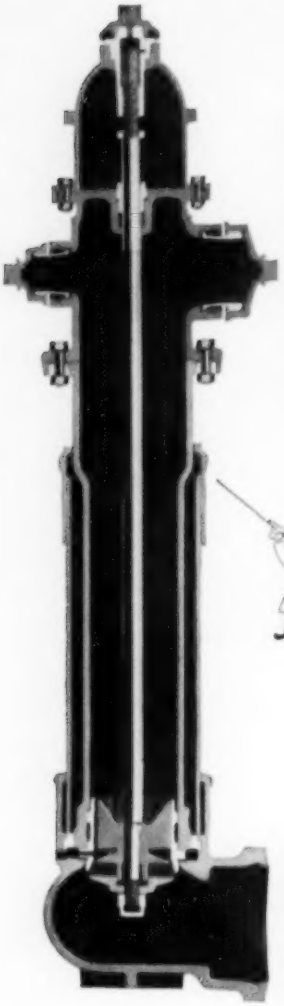

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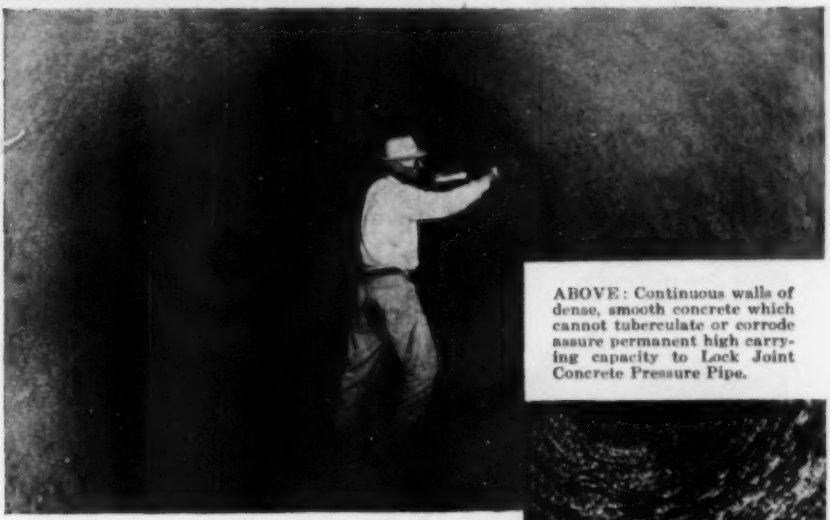
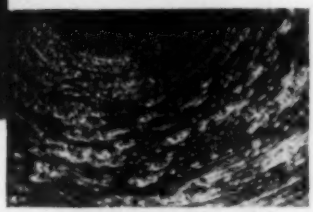


ABOVE: Continuous walls of dense, smooth concrete which cannot tuberculate or corrode assure permanent high carrying capacity to Lock Joint Concrete Pressure Pipe.



ABOVE: The tuberculated condition of this metallic pipe reduces its carrying capacity 50%.

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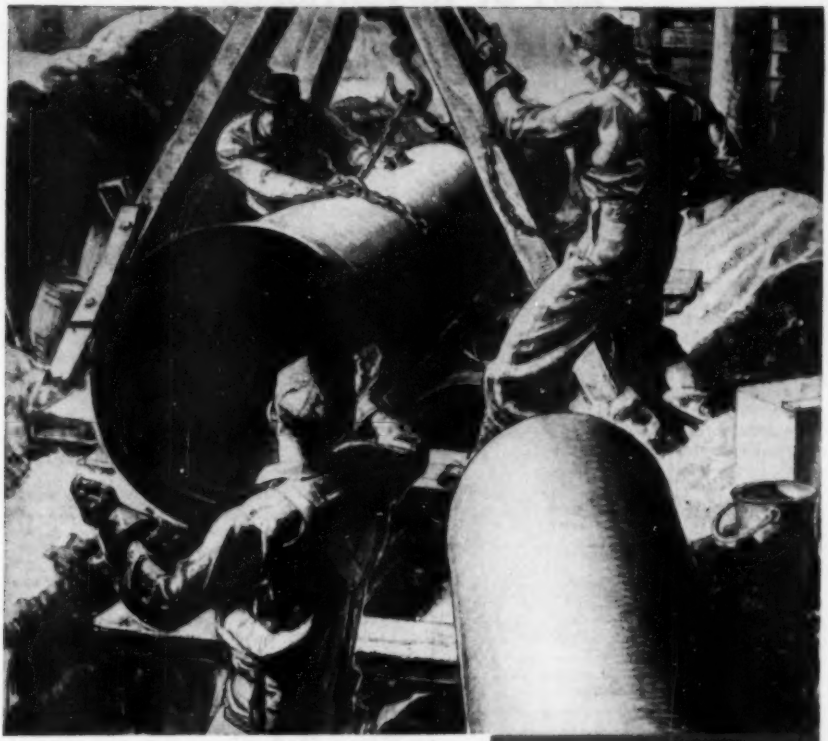

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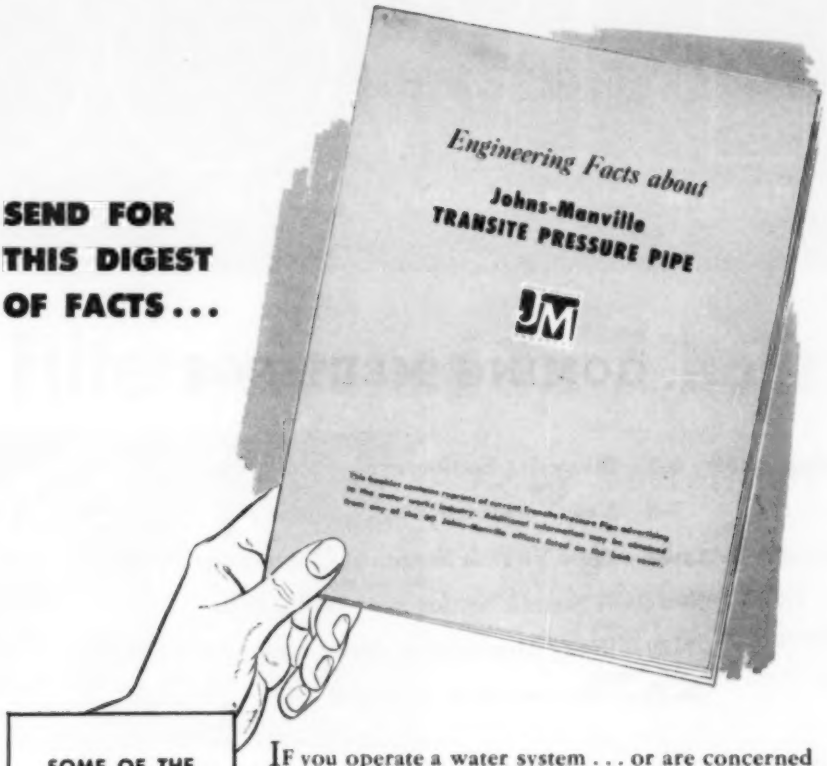

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13–14—West Virginia Section at Huntington, W.Va.

19–21—Wisconsin Section at Oshkosh, Wis.

27–29—Rocky Mountain Section at Santa Fe, N.M.

28–29—Ohio Section at Columbus, Ohio.

October **1–3**—Missouri Section at St. Louis, Mo.

11–13—Alabama-Mississippi Section at Mobile, Ala.

15–18—Southwest Section at New Orleans, La.

18–20—Pennsylvania Section at Pittsburgh, Pa.

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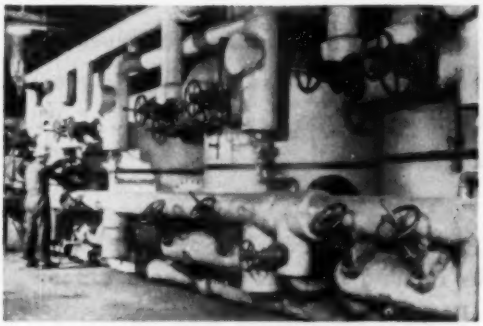

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July 1950

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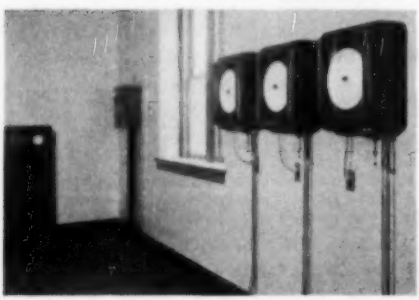

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Journal
AMERICAN WATER WORKS ASSOCIATION
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Young Men in the Water Works Field

By W. Victor Weir

An address presented on May 25, 1950, at the Annual Conference, Philadelphia, by W. Victor Weir, President, A.W.W.A.

THERE are many problems in the water supply industry. There always have been, and I hope there always will be. As we solve one problem, we find we are confronted with two more. Some are created for us, such as high prices, high wages and the shrunken size of the dollars we get for the water and the service we supply. We are not individually responsible for the inflation which has occurred in the last ten years, but we must face up to the results.

The pollution of our streams and lakes has made it more difficult to produce a palatable water, although we know how to make it safe. The erosion of land through bad farming practices increases the silt load of streams, making our jobs more difficult. The possibility of having to handle pollution from radioactive wastes opens a new vista of problems.

We find many human problems confronting our industry. The relations of employees and management have undergone changes in recent years. We have shorter working hours, more holidays and vacations, retirement pensions and welfare plans to think about. We have had these problems all along, but we are doing more about them now.

In addition to these and other problems we have not asked for but must meet, are the many we are deliberately creating for ourselves. Instead of being satisfied with things as they are, we are questioning our old practices and methods and the materials and equipment used. We are asking ourselves: What better things can we obtain? What better techniques can we use? What may we do to improve our product's quality or make the service more reliable?

This approach to our work, this attitude of constructive self-criticism, is entirely healthy. Making new problems for ourselves—recognizing in

things which have been taken for granted real problems which should be tackled—is a sign of progress. Of course, one big question is: How are we going to solve all these problems?

The cost of one B–36 airplane is $5,757,000. That money would build a pretty good water system for a city of 75,000 people. When such a plane is sent into action, it is in charge of an officer possibly 25 years old. The "old man" of the crew is probably not over 28. Those millions of dollars, and the lives of the crew, are the responsibility of young men, who are trained, to be sure.

Much of the research on the structure of atoms, much of the work on developments in abstract science, is being performed by young people in their twenties and early thirties. There is indeed an "accent on youth" when new concepts, new ideas and new machines must be coped with.

Are we in the water works industry getting hold of our share of these young men? Are we properly training them to solve our problems? Are we selecting, from college and university graduates, the promising individuals to go into our plants and offices for training, as many industrial concerns do? I believe our industry is important enough to warrant a deliberate effort to do just that. I believe our problems can best be solved by following such a course.

I will say little about the training received in colleges and universities. Curricular improvements have steadily been made, particularly in the broadening courses available with an extra year in school. The graduates have generally received good basic training when they start to work.

Of more concern to us are two questions: How are we to get these young chemists, engineers, accountants and the like into our industry? And how are we to develop them after they start working for us?

There is competition for the most promising of each year's crop of graduates. To purchase a young man's services, it is not enough merely to meet the going salary; the promise of opportunity for advancement must also be given him. The latter is the more important. The young man is going to weigh a future in the water works industry against a future in another field he might enter. Verbal assurance of what he can expect will not impress him greatly. He will want to know what has happened to the men five, ten and 20 years out of school in the water system he is considering. He will gather, by looking at the office, the plant and the employees, whether he is being asked into a well organized, modern, efficient system where hard work and production are rewarded.

There is no valid reason why the water works industry should offer less than does any other industry. Our industry is growing. Eighty million dollars of water works construction contracts have been awarded in less than four months in 1950. This amount averages more than $5,000,000 a week, 85 per cent greater than in 1949. There exists a backlog of planned water works projects totaling 1½ billion dollars, enough to support the 1949 rate of activity for six years.

Our industry is second to none in importance in the community and possesses a stability not equaled by other industries, because water is the most basic of all commodities. These factors are attractive to any new employee, but an ambitious young man—and that is the only kind who will help solve our problems in the future—will be more interested in whether the man who holds the position he would ex-

pect to occupy later considers his job challenging and adequately paid. He will want to know that when he becomes superintendent or manager he will not receive half or two-thirds the salary a man with similar ability and experience would get elsewhere.

As an industry, we have the problem of making our laboratories, offices and plants desirable places in which to work, and the personnel must have adequate salary schedules. Such things require money, and many utilities will have to raise their system incomes by increases in water rates. Remember, the water departments are competing with other industries for these graduates, and salary schedules suited to political appointees are not sufficient.

Getting a promising graduate is only part of the job. He must still be trained in many things which he could not be taught at school. He must acquire the experience which comes from rubbing elbows with many kinds of men. He must learn by doing.

Large industries bring their college graduates in as student employees. After spending enough time in several departments the young man is put where he fits best. He has, however, acquired a wealth of general information about many phases of the operations and sees his permanent job in its proper perspective. Newcomers in our organizations should likewise be informed about many more jobs than their own.

An accountant will be more valuable if he has a general comprehension of the production, distribution and construction practices. He will be recording items he understands, not just totaling figures which are meaningless to him. His work will be more interesting and he will make fewer mistakes. A distribution engineer should be well informed about the problems in the plant. You may need him there in an emergency some day. He should also be acquainted with the commercial side of the business. He should know how his records must be handled in the accounting department. When he realizes how the various phases of water supply operations mesh together, he will probably be able to conceive new ideas for more efficient operation. The same can be said for new employees in the production end or in the laboratory and for those meeting the public. All will be improved if their knowledge and experience cover fields beyond their own specialty.

The horizons in the water works industry, however, extend beyond the outskirts of the particular water system. If a young man is to learn the water works business and be an individual you can depend upon to solve problems, he must know what is going on in other systems. He must know of the improvements being made elsewhere. If he is aware of the mistakes and failures of others, he will be in a better position to prevent them in his own system. He must have an opportunity to read of these happenings, and he should meet and talk to the men who can guide and teach him. These are things which will accelerate the training necessary to make a young man a valuable employee.

An adequate library should be available. Current water works periodicals should be given him, and time should be provided so that he may read them. The young man should be made to feel that he is part of an industry which is active and progressive. Membership in this Association will give him a sense of belonging professionally, and the JOURNAL will challenge and educate him. The cost will be less than 0.5 per cent of his wages, an amount

any employer should be glad to pay, since the returns in employee value will be several times the expense. If I were to be asked what single thing helped me the most in my water works career, the answer would be that, as a cub engineer, less than a year out of school, I was sent from St. Louis to the Annual A.W.W.A. Convention in New York.

It will not be possible for many new employees to go to the annual conventions, but every effort should be made to have them attend the section meetings. They will meet on easy terms the men who can help them in their careers. The discussions in and out of the meeting rooms will give them the experience of others. No better way exists to make an employee valuable speedily.

If I could talk to an audience of young water works engineers, accountants and bacteriologists who were not members of the Association, it would not be difficult to show them that the A.W.W.A. membership dues are a small price for being part of the active, growing professional organization in the field of their work. The Association can give them assistance which, as they develop, should return many times $10.00 per year in salary increases.

This audience is, however, not of that kind. Those younger men are at home so that we older (generally speaking) ones can be here this week. I would like to ask a question of you who are top utility executives, public or private, you department heads, you experts in scientific jobs, you men in charge of plants and laboratories and offices, you whose firms are called in to give us consulting advice, you public health officers, you city officials: What would be an employee's reaction if you said to him, "You're doing good work. You're in an industry which is much bigger than our local operation, and it is necessary that more of us know what is going on elsewhere so that we can adopt good ideas here. Now, both as recognition of the good professional work you have been doing and as a means of broadening your horizons so that you may do even better work for us, we are going to make you a member of the American Water Works Association"? If you said that, I am sure you would have a better employee immediately and would be developing a real assistant in a few years.

Young men, if they are to solve our problems, must develop initiative, understanding and responsibility. None of these attributes develop themselves. Remember, in the last war our end was upheld by young men. These men handled their crews, and their million-dollar power plants and devices more intricate than anything we have in our water works installations, with complete credit. They made decisions. We relied upon them successfully.

There is no reason why the young men coming into our organizations should not acquit themselves as well, if we train them properly—if we increase their initiative, if we progressively give them as much authority as they can carry, if we develop responsibility by requiring them to make decisions.

We need young men, the best obtainable, in our water works organizations. We must meet the competition of other industries in the matter of wages and advancement. We must train these new employees properly, for these are the men we want to do our work in the future, and we want them to do it better than we do it today.

Reorganization of Federal Agencies for Natural Resources Development

By Gilbert F. White

A paper presented on May 23, 1950, at the Annual Conference, Philadelphia, by Gilbert F. White, Pres., Haverford College, Haverford, Pa.

THE United States is at a crucial stage in the development of its water resources. A new concept of unified drainage basin planning is now deeply embedded in public thinking. Although a huge volume of public expenditures is in prospect to translate this concept into dams, canals and power plants, the organization to carry out these programs is in a state of flux, and the policy to be followed in financing and judging the feasibility of the needed works is ill defined.

It seems likely that the next few years will see a crystallization of federal organization in the water field. A review and revision of national water policy is needed urgently, and the first step in this direction is now being taken by a presidential commission. The A.W.W.A. has already expressed its judgment on the broad outlines of a national water policy (1). Water works men can also play a role in helping to improve the organization of federal and state efforts to carry out the prevailing policies. To explain this role, it is necessary first to discuss the findings of the Hoover Commission ("Commission on Organization of the Executive Branch of the Government") and its "Task Force on Natural Resources" (2, 3).

Present Situation

Three basic facts stand out in the Hoover Commission reports. The first is that the concept of the unified development of water resources in river valleys is now clearly accepted by the public and by government agencies. The idea of a multiple-purpose project, as symbolized by Hoover Dam, is here to stay. In future it will not be enough to build dams or river control works for single purposes if it is practicable to combine other objectives within the limits of public policy and finances. It also is apparent that public participation in the production and transmission of electric power from multiple-purpose dams is, and will remain, a major government function. The planning of water control works will in future take the form of unified drainage basin programs. The day when one water project can be considered independent of others in the same drainage basin has passed. This statement is presented as a "fact" because the idea of unified programs is firmly imbedded in the survey reports —prepared by federal and approved by state agencies—which form the basis for the huge volume of new construction authorized by Congress during recent years.

The second major fact in the present water resources situation is that the volume of public expenditures in the near future promises to be equal to, or in excess of, the current level. The whole group of federal water development projects under construction in 1948 involved an expenditure of about five billion dollars, an amount greater than the total spent for all projects in all the years preceding June 30, 1947. At the same time projects not yet under construction, but proposed in the advance programs of the various federal agencies, called for an estimated expenditure of four times the amount for projects being built.

The third major fact is that, in considerable measure because of the rapidly growing volume and scope of federal work in water resources, there has developed a highly uneconomic and inefficient administrative organization. It was natural that over the years, as the small and scattered federal efforts toward water conservation took shape, the accompanying national policies should be on a piecemeal and limited basis. Gradually a whole series of unrelated policies in the field of flood control, navigation, irrigation and power has found its way into the federal statute books. At present there is no uniformity in the methods of determining project feasibility or in the basis, if any, used for charging costs to local beneficiaries.

Moreover, there is an unfortunate division of responsibility for water development among the Army Corps of Engineers, the Bureau of Reclamation, the Federal Power Commission and a few associated agencies. The result is a large amount of interagency competition and an increased centralization of authority within the contesting agencies. In the western states, the Corps of Engineers begins downstream with navigation, the Bureau of Reclamation begins upstream with irrigation and the two collide midway, as in Hell's Canyon in the Columbia Basin. Thus far there has been no adequate way of reconciling the major differences between the Corps of Engineers and the Bureau of Reclamation. The ordinary Bureau of Budget review has proved inadequate because of lack of staff and authority, and because disputes among federal agencies arise too late to be reconciled in the preparation of reports.

The two major agencies have sincere and competent personnel who are genuinely interested in river development in the public interest. Nevertheless, conflicting federal policies and divided responsibilities force them into intolerable situations.

Recommended Reorganization

The Hoover Commission report, together with its accompanying task force report, recognized these facts and recommended a series of administrative measures to deal with them. The commission was not united on its own recommendations and did not accept all of those submitted by its Task Force on Natural Resources. There was substantial unity on a few points, however. All parties agreed that, in order to strengthen state participation in water development and to decentralize federal activities, special advisory commissions should be created for each major drainage basin, with each state being asked to appoint a representative. The commission and its task force joined, except for two dissenting votes, in recommending that the flood control and rivers and har-

bors work in the Corps of Engineers be transferred to another department and merged with the functions of the Bureau of Reclamation to form a national water development service. With one member dissenting, the commission urged that a special board be set up to review and report to the President and Congress on the public and economic value of project proposals in the natural resources field.

Three members of the commission submitted a separate report in which they joined with the task force in recommending a new department of natural resources, to include a water development service and a forest and range service. The majority of the commission had suggested that the latter be placed in the Dept. of Agriculture, combining the present Office of Land Management and the Forest Service. There was disagreement on this recommendation as well.

Not withstanding these differences of opinion, there runs through the entire task force report, and the report of the commission and its individual members, a strong feeling that some sort of national agency dealing with water and related power problems should be created and that it should be encouraged to operate on a strongly decentralized basis. The new water agency's programs, along with those of other agencies in the natural resources field, should be subject to the review of an impartial appraising agency. It is reasonable to expect that the President will submit plans for reorganization along these general lines.

There probably never will be widespread agreement on the most effective ways to deal with the reorganization of federal resources activities, but the consensus seems to be that the current arrangement is unsatisfactory and leads to unnecessary waste in the use of public funds. The present situation cannot be allowed to continue without costing the country tremendous amounts of money spent on unwise projects and without involving a large and disturbing degree of friction among federal and state agencies.

Possible Lines of Action

At the risk of oversimplification, it may be said that there are three principal courses of action from which to choose: [1] to maintain the *status quo* at heavy cost to the public treasury; [2] to effect an administrative reorganization along the general lines recommended by the Hoover Commission and its Task Force on Natural Resources; or [3] to establish valley authorities similar to the TVA in other parts of the country.

Of these choices, the second seems to the author by far the most practicable and desirable, although its adoption is not entirely assured. There is tremendous opposition to any shift in federal organization that deprives agencies of established power and authority. It may well be several years before there is any substantial change in the government organization for river valley development. But to the extent that such reorganization is delayed, the tendency to resort to valley authorities as the easy solution is fostered. Experiences like those at the Kings River and in the Missouri Basin lead to increasingly widespread public feeling that only by the valley authority organization can river basin development be attained. It has been shown, the task force believes, that virtually all of the benefits which result from valley authority organization can be obtained

through national agencies properly organized, and that a network of valley authorities would cause unnecessary complications.

Neither a new national water agency nor a system of valley authorities would, in itself, change or extend the present range of federal activity and regulation affecting water. Either type of organization would require close cooperation with local and state agencies in order to be effective. But experience suggests that the failure of a national agency to work effectively with strong state and interstate groups will lead to popular demand for a valley authority.

The task force did not favor valley authorities at this time, but it did feel that they are distinctly preferable to the present situation and that they would be necessary if the recommendations of the Hoover Commission were not adopted promptly. Thus, it would appear likely that, unless a major reorganization of the type recommended by the Hoover Commission is effected in the near future, there will be strong support for the establishment of valley authorities in various parts of the country.

It may be asked what steps should be taken to back the recommendations of the Hoover Commission. In the author's opinion, support should be given to whatever plans the President presents to Congress on the basis of the Hoover Commission recommendations. In addition, the establishment and activities of organizations such as Incodel, which provide state and interstate participation in water development by federal and state agencies, should receive vigorous encouragement.

Although there are a few basins, like the Colorado and the Delaware, in whose development water works operators are taking a hand, there are far too many in which they are failing to apply their local experience to solutions of water problems on a large scale. They can perform a useful function by supporting steps to put the federal household in order and by promoting state and regional organizations to take concrete parts in planning and operating new projects.

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Development Plans for the Delaware Basin

By James H. Allen, Malcolm Pirnie and Francis S. Friel

A panel discussion presented on May 23, 1950, at the Annual Conference, Philadelphia, by James H. Allen, Exec. Secy., Interstate Com. on Delaware River Basin, Philadelphia; Malcolm Pirnie, Partner, Malcolm Pirnie Engrs., New York; and Francis S. Friel, Pres., Albright & Friel, Inc., Philadelphia.

Introduction—*James H. Allen*

THE program for the development of the Delaware River Basin is the greatest water conservation project ever conceived. It is designed to serve a region which, commercially and industrially, outranks any comparable area in the world. Approximately 20,000,000 people—more than one-eighth of the population of the United States—will be benefited.

This project was originated by the Interstate Commission on the Delaware River Basin, popularly known as "Incodel." The seed was sown at Incodel's annual meeting in June 1948 and is now beginning to blossom, as this panel discussion will show. Before going into detail, it may be well to explain just what Incodel is, how it came to be and how it operates.

Background

Before Incodel was born, the Delaware Basin states—Pennsylvania, New York, New Jersey and Delaware—on numerous occasions had come to grips over problems crossing state boundaries. Many years of discord, with each state jealously guarding its own interests in the Delaware River, indicated the dire necessity for an overall coordinating agency in the control and utilization of the resources of the basin. This background of interstate conflict, coupled with the alarming trend toward federal assumption of power over water resources programs, led the states in 1936 to form the Interstate Commission on the Delaware River Basin.

The new commission laid the foundation for what it hoped was to be its future in a problem-beset area. It had determination and a great idea. Its members believed that they could avert federal domination of the Delaware Basin by demonstrating the capacity of these state governments to effect regionwide cooperation in controlling the resources that are the province of no one state. Therefore, the commission dedicated itself, in behalf of its four supporting state governments, to the cooperative development of policies and programs for the conservation and wise use of these resources.

Operation of Commission

The commission consists of twenty members, five from each state (a state senator, a member of the state house of representatives, a member of the governor's cabinet, an officer of the

state planning board and a delegate at large).

Incodel is essentially a service and coordinating agency; its powers are advisory; its weapons are conversation and persuasion. Incodel has no administrative powers, it can pass no laws and it can neither finance nor construct. The commission operates with a small staff, on an annual budget made up of equitable appropriations from the four participating states.

The primary objective of the commission is to resolve major problems which have been plaguing the states for years—stream pollution abatement, water supply, soil and forest conservation, recreation and related activities. Programs which the commission develops and sponsors are referred to the respective state governments for approval, adoption and administration. Truly, the Incodel approach is democracy at its best.

1950 Survey Report—*Malcolm Pirnie*

The legislatures of New York, New Jersey and Pennsylvania, in 1949, directed the Interstate Commission on the Delaware River Basin to have surveys and studies made of the water resources of the Delaware River Basin; and to report before the end of 1950 on the feasibility and advisability of future construction of an integrated water supply project on the Delaware River above Trenton.

In July 1949 the commission engaged Malcolm Pirnie Engrs. and Albright and Friel, Inc., to proceed with studies and surveys divided into two parts or phases. The first part, on which a preliminary report was submitted to the commission in January 1950, was confined principally to a basic analysis of the problem and to devising general plans for one or more integrated water projects which appear to be advantageous and worthy of further study.

The second step of the survey, which is now in progress, consists of detailed studies, surveys, analyses, preliminary designs and cost estimates for the project as recommended in the preliminary report and as approved by the commission. It also includes recommendations and estimated costs of a program for financing, construction and operation of the project, and consideration of intergovernmental negotiations and legislative requirements necessary to implement it.

The purpose of this paper is to present a detailed analysis of the project as covered by the first step of the survey—the need for the project and its scope and future. It is of vital consequence to mention here that this is the first time a survey has been conducted on a coordinated interstate basis, and it is on this basis that the project will reach fruition.

Although the principal purpose of the survey is to advance the development of additional facilities to meet the respective water supply requirements of the metropolitan areas within and near the Delaware River Basin, the survey includes plans for using the projected works to provide or benefit stream flow regulation; flood, pollution and salinity control; oyster and fishing resources; recreation; power production and navigation.

Unquestionably the greatest need for the present and future utilization of the water resources of the Delaware River is for stream flow regulation

and the production of adequate supplies of potable and industrial water. Beginning in 1942 the accelerated growth in population and in per capita use of water in the metropolitan areas within and near the basin has taxed the limited capacities of the existing major sources of supply up to or beyond their dependable yields.

Existing Supply Situation

Before going into the construction aspects of the proposed project, it may be well to summarize briefly the existing water supply situation in the basin areas.

The greater portion of water for the northern metropolitan district of New Jersey is supplied by five major reservoir systems—the Wanaque, of the North Jersey Dist. Water Commission; the Rockaway, of Jersey City; the Pequannock, of Newark; the Passaic, of the Passaic Valley Water Commission; and the Hackensack, of the Hackensack Water Co. (*see* Fig. 1).

The total dependable yield of these five supply systems, plus 30 smaller ones, is estimated to be 388 mgd.—less than the consumption, which increased from 270 mgd. in 1940 to 390 in 1948. (It will be recalled that only rigid conservation helped avert a complete failure in the water supply of this region recently.) An additional supply estimated at about 200 mgd. will be needed in this rapidly growing area within the next 25–30 years, and at least 400 mgd. will be required within 50–60 years.

New York's water history has been a series of crises, with new sources coming into operation just as consumption caught up with and passed supply. The existing available supplies have an estimated dependable yield of approximately 1,050 mgd., and the average consumption of water in 1948 exceeded 1,200 mgd. The praiseworthy compliance of the people of New York City and Westchester County with drastic conservation measures initiated in October 1949 has reduced the consumption by more than 20 per cent, compared with the previous corresponding period.

The U.S. Supreme Court, in 1931, permitted New York City to divert 440 mgd. from the Neversink and East Branch of the Delaware River. This diversion, together with the Rondout Creek development, will provide an additional 540 mgd. when the project is completed. The depression delayed the financing of the project until 1937 and construction was further retarded by World War II. The Delaware Aqueduct, between Rondout Reservoir, Kensico Reservoir and Fort Greene Park in Brooklyn, N.Y., has been completed, however, and is being used for diverting natural flows from Rondout Creek to West Branch and Kensico Reservoirs, and transmission service from Kensico to Brooklyn. Rondout Reservoir will be completed this year, Neversink Reservoir in about two years and the entire project about 1955, thus providing full-capacity service in 1956. New York City's dependable supply will then be more than 1,500 mgd. As an interim safety factor, the city has recently awarded a contract for an emergency supply of 100 mgd. from the Hudson River below Poughkeepsie, to be pumped into the Delaware Aqueduct for delivery to the West Branch and Kensico Reservoirs.

It is estimated that an additional amount, at least 200 mgd., will be needed by New York 25–30 years from

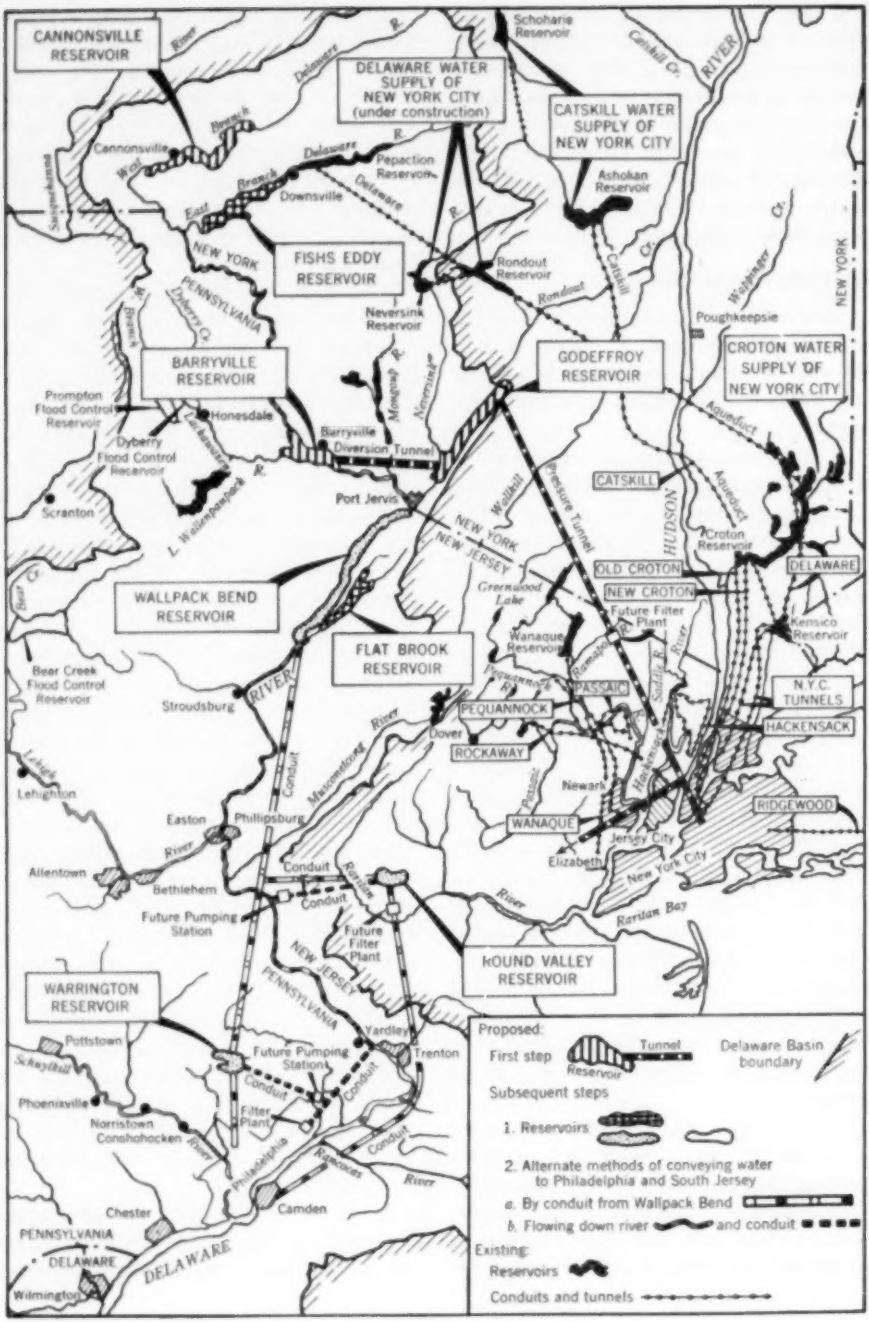

FIG. 1. Delaware Basin Development

now, possibly increasing to 400–500 mgd. in 50–60 years.

The southern metropolitan district of New Jersey, which extends from north of Trenton to south of Camden, consumed about 75 mgd. in 1948, of which 21 mgd. was furnished from

is believed that any long-term program for the utilization of Delaware River water must provide for the future needs of this area.

The survey has considered a large number of plans for providing future needed water supplies for areas in and

TABLE 1

Summary of Data on Proposed Reservoirs

Location and Stream	Drainage Area *sq. mi.*	Pond Area *acres*	Elevation—*ft.*			Storage—*bil.gal.*			Daily Yield *mil.gal.*	
			Flow-Line	Stream Bed	Max. Water Level	Total	Reserve (25%)	Net	95% Year	98% Year
Cannonsville, N.Y. (W. Branch Delaware R.)	450	5,320	1,163	1,000	163	117.5	29.4	88.1	395	371
Barryville, N.Y.-Pa. (Delaware R.)	2,756	1,080	630	550	80	9.8		diversion only		
Godeffroy, N.Y.* (Neversink R.)	209	9,480	620	475	145	277	40**	237	274	271
Combination of above								325.1		1,038
Fishs Eddy† (E. Branch Delaware R.)	446	7,170	1,100	910	190	157	39.2	117.8	514	479
Flatbrookville, N.J.‡ (Flat Brook)	65.1	3,500	520	350	170	83.6	20.9	62.7	70	70
Wallpack Bend, N.J.-Pa.§ (Delaware R.)	3,270	9,500	420	325	95	121	30	91	1,070	974
Warrington, Pa.‖ (Little Neshaminy Creek)		3,070	295	220	75	25.6	5.7	19.9	storage	
Lebanon, N.J.# (Round Valley)		2,400	400	240	160	64	16	48	storage	
Combination of above								664.5	2,090	

* Neversink Dam development deducted.
† Downsville Dam development deducted.
‡ Development to yield mean flow.
§ Yield adjusted for upstream diversion for New York City development and proposed Incodel development.
‖ 50-mgd. approximate yield from Delaware R. diversion.
100-mgd. approximate yield from flood storage.
** Below elevation 530.

the Camden ground water supply and 28 mgd. was obtained from the Trenton Delaware River supply. The remainder was obtained from small well and surface sources. Because of increasing industrial development in this area, it is estimated that consumption will rise considerably in future. It

adjacent to the Delaware River drainage basin and for improving the condition of the river. Studies indicate that there is sufficient drainage area, rainfall and runoff in the basin not only to meet the probable future water needs of Greater New York, metropolitan New Jersey, Trenton, Camden, Phila-

delphia and adjacent areas, but also to provide sufficient regulation of river flows to improve the river for recreation purposes and prevent the intrusion of sea water upstream in the lower reaches of the river. Large storage reservoirs will be required in order to withhold flood flows which are now wasted.

Although these studies have been of a preliminary nature and may be modified, an overall plan of development is presented which is now believed to be most promising for an economical, integrated water supply system (*see* Fig. 1 and Table 1). It comprises two general stages of construction.

Stage One

The first stage consists of a storage reservoir on the West Branch of the Delaware River below Cannonsville; a diversion dam on the main river below Barryville to divert excess river flows to a large storage reservoir in Basher Kill Valley, the reservoir being formed by two dams, one on the lower part of the Neversink River and the other just south of Phillipsport; a tunnel connecting Barryville with the Neversink; and a tunnel from near the north end of the storage reservoir extending across the southwest corner of New York State and the northeast corner of New Jersey into Brooklyn. This 65-mile tunnel will deliver water to the northern metropolitan area of New Jersey and the water supply system of New York City by connections with existing large-capacity transmission systems.

The dam at Cannonsville will be an earth structure with a flowline at elevation 1,163. It will have a total storage capacity of 118 bil.gal. and a net drawdown capacity of about 88 bil.gal., leaving approximately 25 per cent above the dam in the driest years. The dam will be about 2,000 ft. long and 170 ft. high. The site has a steep rock slope on the east side, suitable for spillway and discharge control facilities. Bedrock at the stream is approximately 100 ft. below the surface. The reservoir will impound flood flows for release downstream in dry weather. Electric power can be generated at this site as water is released for the most advantageous use of the reservoir.

The dam at Barryville will be of the masonry type, constructed on rock at an excellent site between natural rock abutments 600 ft. apart, located about ½ mile below the new Barryville Highway Bridge. It will have a flowline at approximately elevation 630 and will be designed to permit the passage of flood flows in excess of water diverted through the tunnel, without raising the crest substantially above elevation 630.

The tunnel between Barryville and the lower Neversink River will be approximately 17 miles long and 25 ft. in diameter. It will be a concrete-lined pressure tunnel constructed in rock, designed to have a maximum capacity of at least 6,200 cfs., which will be reduced to about 1,900 when the storage reservoir receiving the diverted waters is filled to its flowline.

The dam on the lower part of the Neversink River will be built of compacted selected earth and will be located across the valley at Godeffroy—the name given to the reservoir—just below the confluence of Basher Kill and the Neversink River. The reservoir flowline will extend only a short distance up the main Neversink Valley but will extend approximately 15 miles up Basher Kill Valley and into Homowack Kill Valley to a point south of Phillipsport. Another earth dam will be required across the valley at this

location to prevent flow northward. Godeffroy Reservoir will have a maximum flowline at elevation 620, a total capacity of approximately 277 bil.gal. and a drawdown capacity of 237 bil.gal. above elevation 530.

The main dam at Godeffroy will be approximately 140 ft. high, above the existing ground level, and 4,500 ft. long. Borings at this site indicate that rock is about 120 ft. below ground level in the valley.

The tunnel from Godeffroy Reservoir will extend from near the north end to a connection with the junction of New York City Tunnel No. 1 and No. 2 in Brooklyn. The tunnel is to be concrete lined, with a length of approximately 65 miles and an average diameter of about 19 ft. If of this size, it will deliver the full water requirements to be supplied from both the first and second stages of development. It may be found necessary, however, to construct a tunnel of half this capacity at present, with provision for its duplication when needed in the future. Godeffroy Reservoir will be a large artificial lake in which the water supplied will be subjected to natural purification processes sufficient to postpone the need for filtration. Land will be acquired to provide for an equalizing basin and aeration, and for filtration when needed. In one parcel east of the Ramapo River in New Jersey, a location has been found at the elevation of the hydraulic grade line suitable for the construction of an equalizing storage reservoir of approximately 1-bil.gal. capacity, an aerator using initially 20 ft. of head and a filter plant.

The map in Fig. 1 also shows the main feeder or transmission lines of the four upland water supply systems of the northern metropolitan district of New Jersey. The tunnel is situated at a relatively short distance east of the large transmission mains of the North Jersey Dist. Water Supply Commission's Wanaque system, Jersey City's Rockaway River system and Newark's Pequannock system. It crosses the large transmission mains of the Hackensack Water Co.'s Hackensack River system. The hydraulic gradient will be such that water can be supplied by gravity to all of these systems, except the Pequannock high-service system. A connection to the fast growing area in Union, Somerset and Middlesex Counties can be made at reasonable cost. These connections would reinforce existing supply, transmission and distribution systems with a minimum of new construction. They would supplement existing systems used to their designed capacities and would result in improved pressures, especially during periods of maximum demand. The advantages of the tunnel location are apparent. As previously mentioned, it provides supply connections to the southern ends of New York's Tunnel No. 1 and No. 2, thereby using existing transmission tunnel capacities to deliver water from both ends in order to supply increasing demands between them. The proposed tunnel location offers similar advantages to the existing North Jersey systems.

The Cannonsville-Barryville-Godeffroy supply system has a total usable storage capacity of more than 300 bil.gal. for water supply and river regulation. Integrated operation of this system will result in a dependable yield of 1,038 mgd. It will deliver 400–500 mgd. for water supply, and the storage for river regulation is sufficient to raise the natural minimum flows in the driest period of record to 4,000 cfs. at Trenton. This project

will meet the future water supply needs of the North Jersey metropolitan district and the areas served by the New York system until about the year 1980. The trend experienced in water consumption would dictate how far in advance of this date one or more units of the second stage of development should be constructed. The project is capable of economical additional development to provide for the needs of the more distant future. Preliminary estimates indicate that the cost of the first stage will be approximately $500,000,000, about 40 per cent of which is for the full-size tunnel and its accessories from Godeffroy Reservoir to Brooklyn.

Stream Flow

Any plan for the utilization of the water resources of the Delaware River must provide for preserving and increasing the natural facilities of the river for recreation, fish and oyster culture and salinity control. This aim can be accomplished by storing flood flows naturally running to waste and releasing stored waters during droughts to increase the flows throughout the entire main river channel.

Studies made in connection with the Incodel Water Supply Diversion Bill recorded the natural daily flows of the Delaware River at the Trenton gage for the period from October 1, 1928, to September 30, 1941. Daily flows exceeded 4,000 cfs. 76 per cent of the time, 3,400 cfs. 82 per cent of the time and 2,500 cfs. 90 per cent of the time. The variations in the rates of natural river flow during the period are given in Table 2.

These figures on measured flows in the Delaware River show the great extremes in the quantity of water during wet and dry periods. Approximately 1,200 bil.gal., enough to fill Cannonsville and Godeffroy Reservoirs about four times, flowed by Trenton in the maximum month. Obviously, large quantities of water, which are now discharged to the ocean more than half of the time as flood and receding flood flows, are available for increasing and improving river flow conditions in dry periods and providing upland sources of needed water supply, if such waters are stored and released as required.

As may be seen from Fig. 2, average natural flows in excess of 4,800 cfs. occur at Trenton 70 per cent of the time, that is, have a 70 per cent duration. Storing water in Cannonsville and Godeffroy Reservoirs from average natural flows greater than 4,800 cfs. and diverting between 400 and 500 mgd. to provide additional water supplies needed by northern New Jersey and New York would reduce the 70 per cent duration figure by only 16. The dry-weather flow at Trenton would be maintained at 4,800 cfs., instead of dropping gradually during 30 per cent of the time to a recorded minimum of 1,220 cfs. In the driest period on record (1930–32), when natural flows were greater than 4,000 cfs. only 53.5 per cent of the time, adjusted flows would have exceeded this volume 26 per cent of the time and would have averaged 4,000 cfs. during the remaining 74 per cent, eliminating

TABLE 2

Variations in Natural Flow Rates

	Flow *cfs.*
Minimum	1,220
Minimum monthly	1,760
Maximum daily	227,000
Maximum monthly	63,290
Average	11,830
Median	7,800

the gradual drop during 46.5 per cent of the time to a 1,220-cfs. minimum.

New York's East Branch and Neversink Reservoirs, situated in the upper reaches of the basin, will gather the greater part of their stored waters during the flood flow quarter of the time and will not extend the periods of

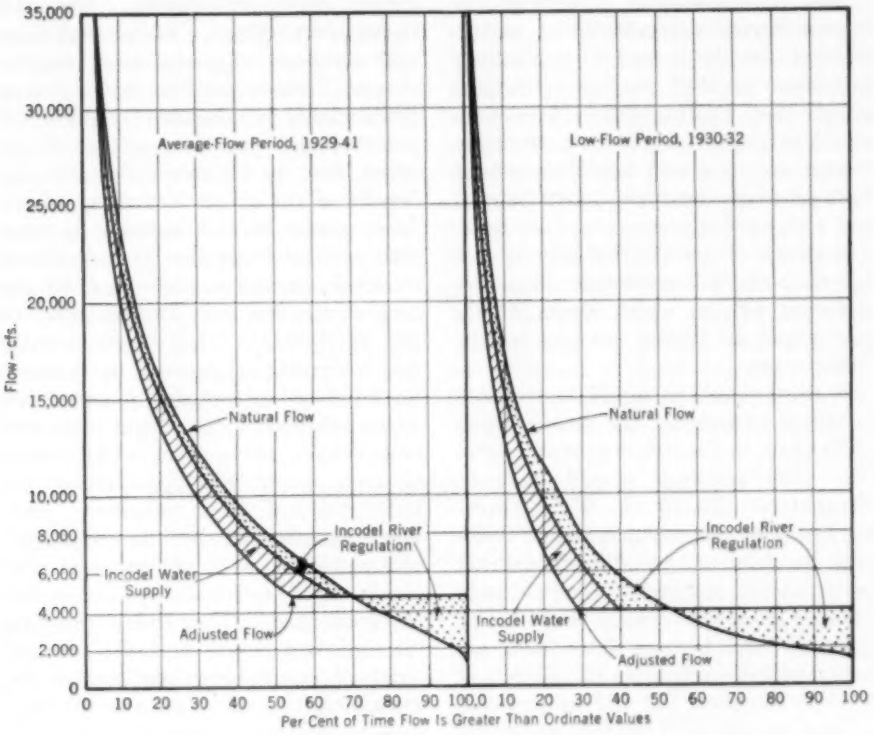

FIG. 2. Duration Curve of Delaware River Flow at Trenton

regulated flow more than 4–5 per cent of the time under extreme drought and average conditions experienced in the period of record.

Stage Two

The second stage of the program (Fig. 1), in addition to maintaining river regulation at Trenton and augmenting it below Philadelphia, provides for furnishing the Philadelphia area and the South Jersey metropolitan area with a supply from the upper third of the Delaware River Basin when desired. This stage also provides additional water for the North Jersey metropolitan and New York areas from the Godeffroy Reservoir, sufficient to meet their needs well beyond the year 2,000. Construction of three additional reservoirs is included.

A large storage reservoir is to be formed on the East Branch of the Delaware River by a dam located below Fishs Eddy. The dam will be an earth type structure with the flowline

at elevation 1,100. The reservoir will have a total storage capacity of 157 bil.gal. and, with 25 per cent held in reserve, a net drawdown capacity of 118 bil.gal. The dam will be approximately 2,000 ft. long and 200 ft. high. Extensive railroad and highway relocation will be required incident to its construction.

The Wallpack Bend Reservoir will be constructed substantially as recommended by the board of consulting engineers in 1946 for an individual supply for Philadelphia. The dam would be a concrete masonry structure, constructed at a very favorable site on rock crossing the main river channel and with rock abutments on both ends. The structure, about 1,850 ft. long and 125 ft. high, will store 121 bil.gal. at elevation 420, of which about 90 bil. gal. would be drawn for use in the driest years.

A third reservoir would be required in future to regulate the stream flows at Trenton in the driest years at 4,000 cfs. The reservoir would be constructed on Flat Brook, which enters the Delaware immediately below Wallpack Bend Reservoir. The dam would be an earth structure approximately 2,500 ft. long and 140 ft. high. The reservoir will have a drawdown capacity of approximately 62 bil.gal. at flowline elevation 520 and will provide a large quantity of stored water for release in the driest years and moderate releases at other times. This site has been considered in many previous studies.

Several methods have been studied for furnishing the Philadelphia and the South Jersey metropolitan areas with water from Wallpack Bend Reservoir in future. These alternatives are indicated on the map in Fig. 1.

Integrated operation of the entire system will produce a dependable yield of 2,090 mgd.

Benefits of Program

The second stage of development, together with stage one, will provide for all the foreseeable water supply needs of New York, the north and south metropolitan districts of New Jersey, and Philadelphia into the twenty-first century. The second stage will continue stage-one river regulation at Trenton and increase it below Philadelphia to minimize the effects of pollution and provide sustained freshwater flow to Delaware Bay for the benefit of the oyster industry. Such flow would be substantially greater than natural flows for 30 per cent of the time, on the average, and 46 per cent of the time in a drought equal to that of 1930–31. Recreation facilities will be greatly improved, particularly in dry summer and fall months; sea water intrusion up the lower river will be held back; and a much better quality of river water will be available for industrial and other purposes. Incidental benefits will include a considerable reduction of flood flows and provision of a limited amount of power for local use. The entire program does not in any way limit the development of other large portions of the remaining two-thirds of the drainage area for additional beneficial purposes.

Hydroelectric Power

Some privately operated power developments situated on the upper tributaries of the Delaware River tend to retard flood flows and increase natural flows in dry weather, thereby providing some degree of regulation. If peak demands for electric power coincided with those for water supply and for the augmenting of natural low river

flows, there would be economic justification for equal consideration of at least three purposes in the full development of a moderate-size river basin. In this latitude, however, peak demands for water supply and for augmenting low river flows occur in dry, hot summer and fall weather, several months in advance of the peak demand for electric power during the short, cold days of mid- and late winter. In these circumstances, the controlling consideration should be the already heavy and rapidly growing demand for the development of the upper Delaware River Basin to meet water supply requirements and maintain river flows much higher than the natural low rate. A substantial amount of electric power can, however, be developed in connection with water supply and river regulation facilities. Such power can be disposed of advantageously by local distribution through the facilities of existing transmission systems. It will have considerable value where recreational use of the basin greatly increases the resident population during the summer.

Flood Control

Although there have been no serious floods along the main stream of the Delaware River, floods on certain branches have caused considerable damage. Such floods occurred on the Lackawaxen River in 1936 and 1942 and on the Lehigh in these years and at other times. The U.S. Army Engineers have developed plans for two flood control dams on the upper Lackawaxen River near Prompton and Dyberry and a flood control dam on the upper Lehigh River below its confluence with Bear Creek. These projects have not yet been constructed, and their storage capacities may possibly be increased to provide some regulation of river flow in dry weather, in addition to service for flood control.

Benefits to Pennsylvania—*Francis S. Friel*

Possibly no similar stretch of waterfront in the nation is so heavily industrialized as the Delaware River from Trenton, N.J., to Wilmington, Del. That this stream is highly attractive to industry is further evidenced by the recent decision of the U.S. Steel Corp. to construct a plant in the area immediately northeast of Philadelphia. It is necessary that these cities, together with other municipalities and industries within the Delaware Basin, be assured of an ample supply of water for human consumption and industrial purposes.

It has been estimated that the areas in eastern Pennsylvania which depend wholly or in part on the Delaware River for water supply will, in the year 2000, have a population totaling 3,836,000, distributed roughly as follows: City of Philadelphia, 2,400,000; Philadelphia suburban area, 1,224,000; and Delaware River subbasin between Easton and Philadelphia, 212,000.

Present Sources of Supply

Water supplies for these areas are at present obtained from various sources. Deep wells serve many small communities and will probably continue to do so as long as ground water supplies are adequate. The larger communities, however, depend upon surface water supplies.

The area above and including Easton is now served by a surface supply. The consumption is approximately 13

mgd., of which about 6 mgd. is taken by Easton from the Delaware River.

Consumption in the Lehigh River Basin, excluding Easton, is about 53 mgd. As the Lehigh River offers an excellent supply and reservoir sites are available, it is assumed that this area can be served independently of the Delaware River.

The region between Easton and Philadelphia is served by fourteen different agencies, which presently supply 8 mgd. Substantial industrial expansion will occur in this area, however, and it is estimated that not less than 30 mgd. will be required from the Delaware River by the year 2000.

The Philadelphia suburban area, which includes parts of Bucks, Montgomery, Chester and Delaware Counties, practically surrounding Philadelphia proper, is served by the Philadelphia Suburban Water Co. from independent surface supplies. The present sources may be inadequate in future, as the region is rapidly increasing in population. Present consumption is about 33 mgd.

In Philadelphia, consumption at present is about 350 mgd., with a peak day in excess of 400 mgd. Approximately 55 per cent of the total water supply is obtained from the Schuylkill and the remaining 45 per cent from the Delaware River.

The pollution and salinity of the Delaware have driven Chester, Pa., from the river. The present consumption is about 12 mgd. The city is developing an independent source on Octoraro Creek to supply 30 mgd., which can be increased to 75 mgd., when necessary.

The comprehensive water works improvement program which Philadelphia is now undertaking, coupled with pollution abatement and stream clearance projects presently under construction in the Philadelphia–South Jersey metropolitan region, will, no doubt, improve present sources of raw water. It is believed, however, that Philadelphia should eventually be served by an integrated water project. The proposed plan allocates 500 mgd. to Philadelphia and also provides 100 mgd. for the Philadelphia Suburban Water Co., 30 mgd. for the region between Easton and Philadelphia and 100 mgd. for the southern metropolitan district of New Jersey. Other sections in the New Jersey–Pennsylvania area can be supplied with water from local sources, although the proposed project can be modified to meet additional needs which may develop in these areas and in the Wilmington region of Delaware.

Effect of Salinity

Periods of low flow have a devastating effect upon the industrial establishments in the tidal estuary of the Delaware River, between Wilmington and Philadelphia. The reduced volume of fresh water in the river permits the movement of salt water upstream from the bay to the Camden-Philadelphia area and has caused the shutdown of some industries depending on river water for industrial purposes. Heavy damage to processing equipment has also resulted. This area, which constitutes one of the most important industrial sections in the entire United States, relies almost entirely on the Delaware River for industrial water.

The serious and extended drought of 1930 resulted in the movement of salinity up the river to Philadelphia, farther than it had ever been observed before. Because of the seriousness of this situation, Incodel, in 1941, made a survey of conditions during the period 1929–40. The section of the river above

the Pennsylvania-Delaware boundary line was subjected to salinity intrusion in the summer and fall of seven of the twelve years involved. In three of the years the degree, extent and effects of salinity were extremely severe; in three others, conditions were relatively serious; and in one, relatively slight. Table 3 shows the degree and extent of salinity in the Delaware River at the Pennsylvania-Delaware boundary line in 1929–40.

Between 50 and 250 mgd. of water is pumped from the Delaware River for industrial and domestic purposes in the region under consideration. Of this quantity, however, only about 28 mgd., on the average, is used for purposes which require a high standard of quality or treatment. About one-half of the industrial supply is used for boiler feedwater and the other half for manufacturing processes. Usually the water is filtered and reduced to zero hardness. It is further desirable, from an industrial viewpoint, that the water be practically free from salinity. Under normal conditions of river flow, this requirement is generally met, and it is during periods of drought that the difficulty arises. The record shows that, in many manufacturing processes, extended high-salinity conditions in the river invariably result in the production of an inferior manufactured product. One of the largest yarn dyeing concerns in the country, which is located on the river, actually had to discontinue its operations in 1941 because of the salinity conditions, and sublet its work to other companies. A paper-manufacturing company was forced to shut down its entire plant for a day because of salinity, putting 1,000 people out of work.

On the basis of the data furnished to Incodel by the industries in the Chester–Marcus Hook area, it was estimated that, when the water in the Delaware River at Marcus Hook reached a state in which the degree of salinity averaged 600 ppm. of chlorides, the annual damage caused by the use of this supply would amount to approximately $73,500, plus $14,960 for each day that salinity of this degree existed. The Incodel report goes on to state that the total amount of the damage for the twelve-year period 1929–40 was estimated at $9,226,600, equivalent to an average annual loss of $769,000. Obviously, a condition which causes such expensive damage should be abated or corrected as far as practicable.

The Cannonsville-Barryville-Godeffroy supply system, which is contemplated under stage one of the development of the Delaware River, has a total usable capacity of more than 300 bil.gal. for water supply and river regulation. This will enable the sea water intrusion on the lower river during dry periods to be held back, while fresh water is continuously provided for the industries located down the river from Philadelphia.

Other Benefits of Plan

An adequate quantity of water will be stored in reservoirs, throughout all stages of development of the water project, for the exclusive purpose of maintaining adequate stream flows to aid downstream riparian owners during periods of low runoff and drought. The value of this phase of the project will be enormous and it will greatly benefit Pennsylvania and the region lying between Trenton and the Delaware-Pennsylvania line, particularly Philadelphia and the area between Philadelphia and Marcus Hook. The river water will be more suitable for

both municipal and industrial use. Increased flows in summer and fall, when they are most needed, will facilitate and assist in the assimilation of effluents from sewage and industrial-waste treatment plants. At the same time the recreational opportunities afforded by the river will be enhanced over its entire length, while waterfront property values will be increased.

The multimillion-dollar oyster industry in the lower Delaware River and Bay, on the shores of both New Jersey and Delaware, should also be a beneficiary. The natural home of the oyster is close to the mouth of the stream, where fresh and salt water mix in approximately equal proportions. The food of the oyster comes primarily from the fresh water. Its enemy, the drill, comes from the sea and menaces the oyster beds only when the supply of fresh water is reduced and the degree of salinity increases. Because the oyster industry could not exist in Delaware Bay except for the supply of fresh water which comes down the river, the release of water from the reservoirs, as planned under this project, will be of great benefit.

Shad fishing will also improve. The project will accelerate the program currently being prosecuted by the Atlantic States Marine Fisheries Commission for the restoration of shad fisheries, once one of the region's most important enterprises.

The river regulation feature of the project will supplement in an excellent manner the very effective stream pollution and stream-clearing projects now being carried on by the states in which the Delaware River Basin is located.

TABLE 3

Delaware River Salinity, 1929–40

Year	Period Salinity Above 50 ppm.		Degree of Salinity *ppm. as Cl*		Avg. Daily Runoff *cfs.*
	Date	No. of Days	Avg.*	Max.	
1929	Aug. 1–Sept. 30	61	260	350	5,400
1930–31	Aug. 1–Feb. 15	198	750	1,150	4,400
1931	Sept. 12–Dec. 31	110	690	1,000	4,950
1932	Aug. 1–Oct. 6	67	725	1,100	3,650
1933	none	0			
1934	none	0			
1935	Oct. 10–Oct. 30	21	100	250	4,500
1936	Aug. 1–Nov. 5	97	370	500	5,300
1937	none	0			
1938	none	0			
1939	July 1–Oct. 31	123	420	650	5,250
1940	none	0			

* For period during which salinity exceeded 200 ppm.

Stream Utilization

Following the publication, in January 1950, of the preliminary report on the utilization of the waters of the Delaware River Basin, some fears were aroused in Philadelphia that New York was trying to steal its water. The interests of Philadelphia, and Pennsylvania as a whole, have been fully protected. The Delaware River

can provide a water supply more than adequate for all future needs. Each year an enormous quantity of water flows through the Delaware Basin past Philadelphia, but only a comparatively small percentage is actually used.

Based on the average flow of the Delaware River during a normal year, stage one of the project would divert only 4 per cent of the fresh water in the river above the Pennsylvania-Delaware line. After full development of the project, the percentage of Delaware River water diverted above the Pennsylvania-Delaware line would be 8.7. The use of the fresh water within the basin itself would amount to 7 per cent of the flow above the Pennsylvania-Delaware line, making the total utilization of the river for water supply purposes 15.7 per cent.

Moreover, the water stored in reservoirs during the wet season for release in the dry period will materially increase the flow in the Delaware River above the Pennsylvania-Delaware line. The Delaware produces too much water in the spring, when the snows are melting and the river is high, and not enough during the late summer and fall, when the river is low. To correct this condition, it is evident that some of the spring flood waters should be saved and released to the river during the dry months, when more water is necessary. (Incidentally, all of the reservoirs for this purpose included in stage one are located in New York State.) More than one-half of the reservoir capacity which will be provided by the project is to be used to store water for release during the low-flow periods. This water will be of enormous importance to Pennsylvania, and to Philadelphia, in both salinity and pollution control. Actually there is plenty of water for all concerned.

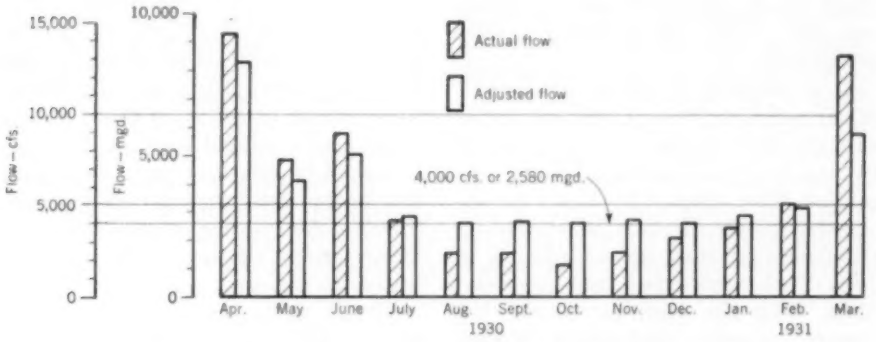

FIG. 3. Effect of Flow Regulation, April 1930–March 1931

Figure 3 shows the flow of the Delaware River at Trenton before and after operation of the first stage of the proposed project. This chart is based upon the lowest twelve-month flow on record for the Delaware River, which occurred during the period April 1930–March 1931. The hatched bars represent the actual flow of the stream each month and the white ones show the monthly flow with stage one of the project in operation.

If the projected reservoirs had existed, the flood or excess waters in the Delaware during April, May and June

1930 would then have been stored and releases would have been made in all subsequent months from July through January. In February and March 1931 water would again have been stored. Figure 3 graphically illustrates the excellent manner in which the stream flow in the lower Delaware River will be improved by the construction of the project.

Significance of Integrated Project—*James H. Allen*

There is now an urgent need for the development of additional sources of water supply for New York City and northeastern New Jersey. As both Pirnie and Friel have shown, however, there is also an equal, if not greater, need for the improvement of stream flows in the Delaware River during periods of deficient runoff, which occur practically every summer and fall. This fact is not generally recognized.

It is obvious, of course, that additional water for New York and northeastern New Jersey can be obtained from a variety of sources. More water for New York City could be secured from the Hudson River and its tributaries or from upland sources in New York State other than the Delaware. But the evidence, considering quality, quantity and costs, weighs heavily in favor of a project for the development of the waters of the upper Delaware Basin. And New York has the right to a limited quantity of these waters, provided it can be secured without detriment to downstream interests. Similarly, northeastern New Jersey admittedly could get additional water by the development of new sources of supply from intrastate streams such as the Raritan River and its tributaries. But, to New Jersey, as to New York, the Delaware is more attractive. New Jersey, too, has the right to a reasonable share of the waters of the Delaware.

Need for Flow Regulation

In contrast to the situation which applies to the water supply problems of New York and northeastern New Jersey, there is only one practicable way in which the flows of the Delaware River can be increased during periods of low runoff in the summer and fall. The only way drought control can be accomplished is by impounding surplus flood flows in the upper Delaware Basin for the exclusive purpose of releasing those waters when vitally needed later in the year. It should be clearly kept in mind that this is the most crucial problem confronting the riparian owners along the Delaware, all the way from its headwaters to the sea.

Floods along the Delaware, fortunately, are not a serious matter. Droughts, on the other hand, have been and will continue to be devastating until a program for their abatement has been consummated. Droughts in the summer and early fall spoil the river for recreation, give the water works and sewage treatment plant operators their greatest headaches, and cause brackish water invasions in the intensely industrialized area in the tidal estuary between Philadelphia and the Pennsylvania-Delaware boundary line, imposing additional costs upon manufacturers for water treatment which have amounted to as much as $2,000,000 a year, based on present-

day price levels. In part, droughts forced Chester, Pa., to abandon the Delaware and go to the hinterlands for a new source of municipal water supply. Droughts permit the drill, the young oyster's greatest enemy, to invade oyster farms and kill off as much as 50 per cent of the potential production in a single growing season. Droughts will be the greatest deterrent to the restoration of the shad fishery after the basinwide pollution program has been completed in 1953 or 1954. Finally, droughts cause new industries desiring to locate along the lower Delaware River the greatest concern about the reliability of water for industrial purposes.

Although no accurate estimate of the damage due to droughts in the summer and early fall has been made, it is indicated that their prevention will be worth several million dollars per year. There are many persons who overlook the value of the drought control phase of the integrated water project. They fail to recognize that the Delaware, like all other rivers, does not flow, under natural conditions, at a uniform rate throughout the year. Overly conscious of the low river flows in the summer and fall, they unthinkingly conclude that the condition would be worsened if water were diverted to New York City and northeastern New Jersey for supply purposes. Nothing could be further from the truth. In the spring and during freshets, many billions of gallons of water rush to the sea, unused and wasted and sometimes causing considerable damage. It is these billions of gallons of water that will be captured, stored and conserved, to the benefit of all interests, for later use in municipal water supply and river regulation.

There are also many persons who seem to be unaware of the U.S. Supreme Court pronouncements on programs for the development of water resources of interstate streams. In regard to the Delaware, the court in 1931 discarded the principle of strict application of the English common law rule of riparian rights in favor of the principle of equitable division of waters based upon reasonable needs. The judicial conclusion was that "the removal of water to a different watershed obviously must be allowed at times, unless states are to be deprived of the most beneficial use on formal grounds. . . . A river is more than an amenity, it is a treasure. It offers a necessity of life that must be rationed among those who have power over it."

New York, New Jersey, Pennsylvania and Delaware are the proprietors of the Delaware River. These states are now joined in a cooperative and sincere effort to develop a plan which will carry out the dictum of the Supreme Court to reconcile their interests "as best they may."

Interstate Compact

The Supreme Court's function is to hear and decide controversies, but it does not welcome having cases brought before it and has said so on several occasions. It prefers, and has publicly recommended, that states resolve their own problems through the medium of interstate compacts. That is the course which Incodel is following, by direction and in behalf of the state governments it serves. A committee composed of representatives of the attorneys general of the four states is now hard at work drafting a compact to establish a Delaware River Basin Water Commission which would be

empowered to plan, finance, construct, maintain and operate the recommended water project.

Philadelphians, and lower river interests, can rest assured that the compact will include provisions which will adequately protect them. It is silly to think that the compact would do otherwise. From the moment of its inception, in 1936, Incodel has done everything within its powers to promote programs for the best use of the precious resources of the Delaware River Basin. This will always be its aim.

The water project will be largely self-liquidating through revenues from the sale of water for supply and possibly hydroelectric power. The cost of that part of the project representing benefits for other purposes—such as flood control, recreation and river regulation—for which charges cannot be directly assessed, should be borne, Incodel believes, on an equitable basis by the states and the federal government.

Federal-State Relations

In the author's opinion, some aspects of the proposed project have far-reaching significance in regard to the vital question of federal-state relations in the development of the country's water resources. This matter is now being considered by President Truman's Water Resources Policy Commission.

In Incodel's judgment, it is a certainty that the project will be built. The only questions are: who will do the job—and how? Incodel believes that the states have sufficient courage and political sagacity to undertake it. By so doing, they will go a long way toward refuting the pet theories of the centralizationists who would spread their tentacles until they eventually acquire jurisdiction over every creek and drainage area in every state in the Union.

The Delaware Basin states will be put to the test in 1951, when Incodel will submit to the legislatures of New York, New Jersey, Pennsylvania and Delaware the previously mentioned interstate compact for the establishment of a commission to build the project. The adoption of this compact will constitute an invaluable contribution toward combating a trend which, if carried to extremes, could easily lead this country into a socialistic type of government.

Should the states fail to effectuate such a legislative program, they will be shirking their responsibility and, thus, be giving aid and comfort to the advocates of nationalization. If the federal government steps in and assumes exclusive control under such circumstances, the states will have no one to blame but themselves.

The proposed interstate water project is a great challenge to the Delaware Basin states. Incodel is firmly convinced that the states will meet it squarely. If they do, they will set an example which could well be adopted as a fundamental principle of a sound national water policy.

The Beginnings of Philadelphia's Water Supply

By Elbert J. Taylor

A paper presented on May 23, 1950, at the Annual Conference, Philadelphia, by Elbert J. Taylor, Chief, Bureau of Water, Dept. of Public Works, Philadelphia.

THE history of the Philadelphia water works has been summarized often during the last 150 years. In each succeeding generation, less and less detail has been given regarding the beginnings. As H. G. Wells pointed out in his *Outline of History*, the number of historical incidents which seem important steadily decreases as the events recede further into the past. This concept is very well suited to expressing history as a continuous and gradual growth but does not lend itself to contrasting or emphasizing the difference in habits, thoughts and knowledge between two periods of time.

Before preparing this paper the author went through the old reports that are to be found in the files of the Philadelphia Bureau of Water. The originals seemed so interesting that it was thought the reader might enjoy the opportunity of making his own comparisons with the present. Consequently, numerous excerpts from these documents will be given.

Philadelphia was laid out by William Penn in 1682. It received its first charter in 1701, at which time there were about 5,000 people living in 700 houses in the city and adjacent areas. By the year 1790 the population had increased to about 43,500. Philadelphia was then the largest and most important city in the country, its greatest port of trade, the capital of Pennsylvania and of the United States. Despite these facts, the streets of the city were generally unpaved, there were no covered sewers, and the water supply consisted of private and public wells, the latter being used for domestic and fire-fighting supplies. Holes were dug adjacent to the gutters to provide for street drainage. Although the public collection and disposal of garbage by contract had been inaugurated in 1768, the sanitary facilities were so meager that the future of the city was not assured.

Canal Project

In 1792 the Delaware and Schuylkill Canal Navigation Co. was chartered by the state for the purpose of forming a link in the great chain of inland navigation between Philadelphia and the Ohio River and the Great Lakes, as well to furnish an abundant supply of wholesome water to all parts of the city and its suburbs.

Yellow fever attributed to refugees from San Domingo resulted in an epidemic which spread terror throughout the city in 1793. At its height, about half the citizens had fled. The cause and mode of transmission of the disease were unknown and physicians aired their opinions in the public press. Most people who remained in the city shut themselves up in their homes, kept off the streets or walked in the middle to avoid contaminated houses. Hand-shaking was abandoned. By

October, after a strict cleanup campaign and cool weather, the epidemic had died out.

In 1797, following a much lighter outbreak of contagious fever, an address and petition, signed by an unprecedented number of the most respectable citizens of Philadelphia, was presented to the select and common councils, soliciting them to introduce water into the city. A brief extract from this petition is given below:

> Your petitioners . . . *earnestly request*, That the Corporation, as *Fathers of the City, as Guardians of the Poor, and the health and prosperity of their Fellow Citizens in general*, will take [this request for the establishment of a water supply to the city] into their immediate, wise and effectual consideration—in doing which your petitioners wish to strengthen your resolutions, by declaring, That, as far as they can collect the sentiments of their fellow-citizens in general, there is *no object of use or ornament* to which a liberal proportion of the city Funds can be more acceptably applied . . . even if no return of interest on the capital were to be expected. We, therefore, have a full confidence in the patriotism of those whom we address, that speedy and effectual means to accomplish the object of our wishes will be devised and pursued.

In response to this plea, the councils appointed a committee to study the situation. It was agreed that the canal company plan was most desirable, provided it could be completed within a reasonable time. The company, however, wanted to retain the full 10 per cent return on investments which the state had set as a maximum for funds expended in supplying water to the city, although 25 per cent was to be the maximum return on the funds expended for the canal. The negotiations collapsed, but the plan is worthy of note. Furnishing water was, of course, contingent upon completion of the canal, which never was finished. The following description of the plan is taken from a letter which the company wrote the councils committee urging an advance of £50,000 to complete the canal:

> The water thus brought into the grand reservoir, to be located on Broad Street extended at Callowhill Street, may, at no great expense, by a Canal cut from north to south along Broad Street, the whole breadth of the city, and bridged over at the crossing of each street, be made to discharge about half a million of cubic feet into the different streets, in one hour—which, taking only ten streets at a time, would send fifty thousand cubic feet into a single street or its gutters in that time, which, by an easy calculation (the descent or fall of the street being known) will appear not only far more than sufficient to fill the gutters, but to overflow and wash the streets, as well as to extinguish fires by night or by day; and thus the first great object of cleansing the streets and subduing the rage of fire might be accomplished, in a few months and with a very inconsiderable expense. The distribution of the water in pipes and conduits and fountains, etc., will follow of course.

Although the above may sound a little fantastic, it was proposed by hard-headed businessmen who were putting their own money into the project.

Latrobe's Plan

Despite the councils' offer of £50,000 for one-half of the water from the proposed canal in 1798, no agreement could be reached on terms and the scheme was abandoned. A substitute plan of Benjamin Henry Latrobe, an engineer, was adopted and work was started in 1799. The plan and many interesting comments are included in Latrobe's letter to Miller, the chair-

man of the councils committee. The contents of the letter, dated December 29, 1798, should be looked upon as the thoughts of an eminent engineer of his time, not from the view of present-day practice and knowledge:

"Agreeably to your request, I now submit to you my ideas upon the subjects which you have communicated to me for consideration: [1] to supply the city of Philadelphia with a sufficiency of wholesome water for culinary purposes; [2] to introduce an additional supply of water for the purpose of washing the streets and, if possible, of cooling the air of the city.

"The indispensible requisites of every work which may be executed appear to me to be the following: [1] The works must be in full operation before the end of July 1799. [2] They must be *certain* in their effects, and *permanent* in their construction. [3] They must not be liable to interruption from ice or freshe[t]s, but be equally useful in the severest winter and in the wettest summer.

"The nearest waters to the center of the City of Philadelphia are those of the Delaware and Schuylkill. I conceive them both to be wholesome, for reasons which I will mention in a postscript, in order that I may not interrupt the consideration of the principal object. It is evident that the exertions of only seven months cannot bring water from a greater distance. In choosing between the waters of the Delaware and Schuylkill, the following considerations occur:

"In favour of the Delaware: it is true that works erected upon the margin of the river would supply water to the city immediately, from the river upwards, and save all the expence, which must, in the other case, be incurred between the Schuylkill and the center square.

"Against the Delaware will operate the impurity of its water, which is subject to a strong running flood tide, and which must be supposed to be contaminated by the decayed vegetables of the marshes over which it passes, independently of the filth thrown from the numerous vessels lying along the wharves or running into it from the public sewers [open ditches].

"In favour of the Schuylkill: the principal circumstance is the uncommon purity of its water; its bed [is] everywhere narrow and rocky, its sources lie entirely in the limestone country, and the tide opposite the center of the town does little more than raise the water by accumulation.

"On the other side: the extraordinary expence of works from the banks to center square may be alledged.

"I believe, however, that you will agree with me in thinking that, as the difference of expence on the largest estimate cannot exceed thirty thousand dollars, there ought not to be a moment's hesitation in preferring the Schuylkill. I shall therefore confine my remarks to that river.

"Neither the waters of the Delaware nor of the Schuylkill can become useful unless they be raised to an elevated level, commanding every part of the city. To do this, in sufficient quantity, very powerful machinery will be required; and I am very certain that human ingenuity has not hitherto invented anything capable of producing the proposed effect with constancy, certainty and adequate force, excepting the *steam engine*.

"Taking therefore all the preceding principles for granted, I submit to you the following proposal: First, to raise a reservoir in Center Square. It is not sufficient that this reservoir should be

elevated so high that it will discharge its water into the distributing pipes. I think it should be forty feet above the level of the pavement, in order that the pressure of the water in so elevated a head may not only propel it to every part of the city, but throw it up into fountains in every street, wherever it may be required.

"A culvert, or tunnel, six feet in diameter, carried underground, the bottom of which should be level with the bed of the Schuylkill, would bring the water into a reservoir in center square, at the depth of about forty feet. Over or near this reservoir, which ought to be a cylindrical well of at least twenty-five feet diameter, the engine house should be erected. Upon the top of the engine house should be the reservoir. With the reservoir all the distributing pipes are to be connected. The engine will keep it perpetually full, being of a power sufficient to supply every possible demand of the city.

"There is, however, a circumstance which may render the scheme impracticable or at all events unadviseable. It is this: The gravel stratum, to which all the wells of this city are sunk, seems to be nearly on a level with the waters of the adjoining rivers, and to be supplied by them with that inexhaustible quantity of water for which it is remarkable. The perfect permeability of the stratum is evident from the connection of the wells with each other, and with the sinks and privies, from whence arises the extreme unpleasantness of the water in the crowded parts of the city. It is worth considering whether the pumps do not act as chimnies to bring up volumes of noxious gas from the putrifying water, which may predispose the inhabitants to receive the yellow fever. Should it so happen, as I believe it will, that the tunnel lay near or in this stratum, it might be difficult if not impossible to keep the work sufficiently dry; and I doubt whether, at any rate, workmen could be induced to labour in this subterraneous situation, which will always be wet and the safety of which may depend upon the certainty of working the pumps above. I shall therefore make another proposal, which is liable to no inconvenience in the execution, but which, though not more expensive at first, will, as it requires two engines, be liable to more *annual* expence.

"A reservoir being made on the banks of the Schuylkill, an engine will throw up a sufficient quantity of water into a tunnel, carried from thence to a reservoir in Center Square. This tunnel should be sunk so low that three feet of earth may cover it in its whole length. The reservoir in Center Square would be sufficiently elevated to supply all the streets from Water Street to Fourth or Fifth Street with water for culinary uses. To supply the rest and to raise fountains for the purpose of washing the streets, a smaller engine would still be necessary.

"It is very evident that, in either of these proposals, the three requisites meet: the supply of water would be inexhaustible; the work might be accomplished in a few months; the ice would never obstruct the operations of the works, as the tunnel would be inaccessible to frost; and the power employed is [of such a type] that . . . the amount and the effect depend not on the variable seasons, or on the natural advantages of situation, but solely on the option of man. In every species of machinery in which mechanical powers alone operate, the bulk, the friction and the unwieldiness of the works encrease nearly in proportion to the effect required; in the chemical operation of a steam engine, power is encreased in a

ratio far outstripping the bulk and the price of the engine, and when the first expence is incurred, the *two* men that are necessary to attend the smallest, can manage the most gigantic mechanism. The expence would be seventy-five thousand dollars.

"Having accomplished this much of the proposed object, enough to substitute pure, for putrifying water, and effectually to provide for cleansing and cooling the streets, a very important part of it still remains unfinished, but which may be a work of more leisure. This is to bring to Philadelphia the spring which turns the mill, called spring-mill, for the sole purpose of supplying the city with water for culinary use.

"It has been generally supposed, and perhaps with great truth, that limestone water has a medicinal effect in bilious cases. The mill-springs form a rivulet gushing from a limestone bason, and, as nearly as I could ascertain it, under all the disadvantages of the season and the want of instruments, it would run through and fill a trunk of from four to five feet in section, not calculating upon a head.

"This quantity would give a perpetual supply to 2,880 pipes, the bore of which should be equal to one-fourth of an inch square, and supposing the water were permitted to run only twelve hours each day, it would supply 5,760 houses with a quantity more than ten times their possible consumption. As the aqueduct, before it reached Philadelphia, would gain a very considerable head, the same supply would be received, but in less time. A more detailed calculation is at present unnecessary; this is enough to show that the spring produces water in sufficient quantity.

"In executing this work, only two objects of indispensible consideration occur: [1] to prevent the quantity of water from being diminished by evaporation or absorption; [2] to preserve its temperature both in summer and winter.

"Both these ends would be attained, by conducting the water in a close tunnel, three feet at least under the surface of all the natural ground, provided with the necessary air holes and air traps, and carrying it [the water] in light aqueducts of segment arches across all the vallies, avoiding every attempt at a forced canal of earth.

"The expence of bringing the water as far as the city would not exceed 275,000 dollars.

"It is evident that in this work the water would never freeze, nor yet acquire any perceptible degree of heat. Only while passing along the aqueducts, it would lose in winter and gain heat in summer.

"Should the mill-spring at any time be found insufficient, the aqueduct, once constructed, might receive, in its course, supplies from all the neighbouring springs, which rise in levels sufficiently elevated, and perhaps convey water to the city sufficient in quantity to render the steam engine on the Schuylkill unnecessary. Even when the first supply arrives, the engines may be dormant from the month of November to the beginning of August.

"I have now to consider the works necessary in the city itself.

"In the first instance, they will consist of wooden pipes of four inches bore, leading from center square, in the following arrangement:

"1. Four pipes down Market Street, supplying at their extremities ranges of cross-pipes of three inches bore, running north and south, in Water Street, Front Street, Second and Third Streets. These pipes will lie under or near the gutters. From them will

branch laterally the leaden pipes which supply each house. The detail of cocks, public spouts, fountains and fire-plugs would be particularly attended to. These four mains will be served from the bason in Center Square, and they must be so connected as at option to be served also from the reservoir upon the engine house.

"2. Four pipes down Chestnut and four down Arch Street, to supply the cross-streets upon the same principle, as high as Eleventh Street. If no more could be accomplished in the first year, it would be sufficient, as the pumps [wells] above Eleventh Street furnish, as yet, very good water.

"In all the pipes, plugs or cocks will be fixed, which, when drawn, will throw up fountains, playing to a height proportionate to the elevation of the reservoir, the lower cock being previously closed. A main of four inches bore, for instance, will, when closed at the lower extremity, throw up, in different parts of the same street, twelve fountains, of an inch diameter each, and thus the whole city may be alternately cleansed and cooled.

"In cases of fire, these fountains will fill the engines without manual labour, by the proper application of a hose. This is of itself an object worthy of the whole expence of distribution.

Recapitulation of Expence

Erecting the engines and bringing water from Schuylkill to Center Square	$ 75,000
Bringing the mill-spring to the city	275,000
Distributing the water throughout the city—first expence	52,000
Total	$402,000

"In order to ascertain the probable proceeds of the works, I will suppose that of 6,000 houses 4,000 families will supply themselves with water from the main. The water-rent which I paid, while residing in London, in a house of 24 feet front, was 36 shillings sterling, or eight dollars. Fixing ten dollars as the *first* average rent, which, as the funds become prosperous, may be annually lowered, this alone would produce an annual rent of 40,000 dollars, independently of extra supplies to brewers, distillers or very large families. 40,000 dollars rent, at 6 per cent per annum, is equivalent to a capital of 666,666.66 dollars.

"I will now add a few remarks upon the following proposals, which have been supposed to be worthy of consideration, and which, indeed, are the only schemes that have come to my knowledge that deserve attention.

"1. As to the Canal—I am convinced that the very eminent and acknowledged abilities of the engineer, Mr. Weston, could overcome any obstacles which art dare combat; and that a work in which he has already done himself so much honour would not want completion, if it depended upon his genius or his industry. If, therefore, the work could be accomplished in time, it certainly would render a great part of the expence which I have proposed unnecessary. But, from what I have heard, doubt may be entertained of the possibility of the necessary expedition. But I confess myself very imperfectly informed. I fear the ice would embarrass the winter supply for culinary use; but to every other purpose its waters would be amply adequate.

"2. Wissahiccon Creek, has, I believe, not a sufficient quantity of water. Besides, to get the water upon a proper elevation, it would be necessary to purchase two mills and then to bring the water to town over very unfavorable ground. The creek has been, even this winter, almost frozen to the bottom and yielded little water.

"3. The examples of London (London Bridge Works) Versailles (Marly) and Bremen would forever deter me from attempting works to be driven by a river, subject to ice and freshe[t]s. The expence of keeping up the timber work is enormous, and equal to rebuilding once in seven years. To give such works power, they must be unwieldy. Cranks, which are their necessary appendage, are the very worst things in mechanism. In the Delaware or Schuylkill, the works might stand still six hours in twenty-four; perhaps during the raging of a fire. I once saw several houses in London burnt down while the works were waiting for the tide. . . . In winter [the works] would be wholly useless.

"4. To bring water in pipes of any description a yard further than necessity requires, is very bad economy. All water has more or less sediment, and pipes cannot be cleansed without taking them up. It is difficult often to find where the fault lies. Metal pipes are very liable to injury from the frost, and, in a long extent, every part could not be equally secured. Wooden pipes, like everything else that is wooden, are a perpetual source of expence, repair and interruption. The inconvenience attending them, in distributing the water, must be borne because it cannot be avoided; but where it can be avoided, it ought not to be borne.

"*Postscript.* I am induced to add still the following remarks, as connected with the subject of my letter:

"1. *Prejudice against river water.* Although most men prefer spring to river water, it may be doubted whether the latter be not the most wholesome. It is certainly supposed by physicians to be more generally free from noxious ingredients. The Indians, I am informed, from motives of health, now grown into habit, never drink water from a spring when they can procure it from a stream. London is entirely supplied with river water. It is taken from the Thames in different places, from the New River and from the River Lee, and has very little to boast of the cleanliness of its aqueducts. The water is received in each house in wooden or leaden cisterns, where it deposits a black impalpable mud. When boiled, the New River water crusts the vessels with a calcareous precipitate, so as in time to choke the spouts of the tea-kettles. I believe that the country in which the river rises has a basis of chalk. The water must therefore be similar to that of the Schuylkill in quality, though very inferior in purity. The houses in London are supplied only once in two days. The water then runs about three hours. Yet during some years' residence in London, I thought it very pleasant, and I am certain it is very wholesome. It is preferred to the water of any spring in the two cities and suburbs, and those that have any fame (such as St. Pauls, or Aldgate) owe it to their coldness, not their superior salubrity. I must remark that I never knew a deficiency of water in my family, notwithstanding the distant intervals between the supplies. The cisterns always ran over during the last hour of the water's coming in. This shows how sufficient our own resources are.

"In this hot climate, however, cool water is more valuable than in London, and perhaps absolutely necessary. The mill-spring seems to possess every desireable quality in a degree which our most sanguine wishes could scarce have expected.

"2. *Fountains.* The engine proposed for Center Square, may be considered as a necessary and unavoidable expence, by whatever means the water is brought to town. It may be ren-

dered an ornament to the city. Its use is to supply water to the higher levels of the town, and fountains to all the streets. They are the only means of cooling the air. The air produced by the agitation of water is of the purest kind, and the sudden evaporation of water, scattered through the air, absorbs astonishing quantities of heat, or to use the common phrase, creates a great degree of cold. Coal mines, which are troubled with foul air, are supplied with pure air by the simple means of pouring a small stream of water, through a trunk, down the shaft into a cask. The air extricated in the trunk and cask is conveyed by means of pipes to distant parts of the works. When the shaft is deep, it will blow out so strongly that a man cannot stand against it. The water-blast used in Switzerland in the furnaces, which is produced by the same simple means, is the strongest that can be devised and, on account of the purity of its air, partakes of the superiority of the chemical oxygen furnace.

"As to the mechanism of the fountains, it consists merely of a short wooden pipe, set perpendicularly into the main, and stopped by cock, which is turned when the fountain is not in use. The *name* produces an idea of great expence, but they may be realised at a very small one.

"3. *Public baths.* I have often wondered that, while in many despotic countries all ranks of men have been provided with the convenience and the wholesome pleasantness of public baths, fountains and porticoes, the American people do not indulge themselves in the smallest gratification, as salubrious as it is innocent, of this kind. Our abstinence is commendable, as it arises from industry and attention to more serious pursuits; but highly blameable, as it injures our health. We retain, indeed, both in our buildings, our diet and our modes of life, the habits of our

FIG. 1. Schuylkill Water Works

northern ancestors, and have not yet learned how to live healthily in a hot climate. In the city of Philadelphia, I think baths almost an absolutely necessary means of health. When the engine in Center Square is at work, it will, with great ease, supply a requisite number of baths. I mention this only as a hint. It might be worth while to look forward to some such thing in the arrangement that may be thought of, provided the preparation may be made without expence. I think it may. Such baths would be a source of a large revenue, and perhaps it might not be bad policy in the citizens of this primary metropolis of North America to counter-balance the fashionable inducements which point to the Potowmac, by conveniences and advantages which cannot for many years be thought of in a city * . . . at present almost destitute of dwellings."

* Washington, D.C., which was soon (1800) to become the seat of the federal government and might therefore be expected to attract some of Philadelphia's citizens.

The first part of Latrobe's plan was carried out, and delivery of water through the distribution system began on January 25, 1801. The difficulty of financing and operating the plant to bring water from the Schuylkill was so great that no further thought was given to the expensive proposal to conduct spring water to the city.

Figure 1 shows the first pumping station, a plain but solidly built structure, located on the banks of the Schuylkill. The water flowed into a pit under the station and was raised about 40 ft. into a conduit which extended to Center Square, now the site of City Hall. There another pumping station raised the water to reservoirs situated about 40 ft. above ground level. As can be seen from Fig. 2, the Center Square station was intended to be ornamental as well as useful.

The reservoirs had a total capacity of 17,660 gal. The Center Square pumping unit was of the walking-beam type and operated on steam pressures of 2–4 psi. The cylinders were of wood, bound with iron bands. Cast-iron flues were immersed in water to produce the steam.

Distribution Piping

The wooden pipes presented immediate and constant trouble. In 1803 an experimental 3-in. cast-iron main was laid in Water Street. The joints did not prove satisfactory, however, and it was decided to turn to England for advice. The following description of the method of making joints is extracted from a letter written by J. Walker of London, dated August 25, 1818:

> Care should be taken to give the pipe a solid bed upon the ground, before the joint is made. There are two ways of making the joint: the first is by lead, the other is by cement. The first operation in making the lead joint is to drive in a ring of dry hemp about an inch in length, to prevent the melted lead from getting round the spigot end into the pipe; after this, some clay, well wrought, is put all round, between the outer end of the fauset [bell] and the spigot pipe, the inside of the clay being kept as nearly as possible to correspond with the outer end of the fauset, and being formed into a cap at [the] top into which the melted lead is run, and, if properly managed, a ring of lead about two to two and a half and three inches, according to the size of the pipes, is formed all round the pipe, being stopped from wasting by the clay at the one end and the hemp at the other.
>
> When the lead is cooled, the clay is removed, and as the lead is contracted in cooling, it has to be caulked, or, as it is here called, upset, by a hammer and chissel, and the joint is complete. The

cement joint is formed by laying the pipes in the same manner as the other, and using in place of the lead a mixture of two pounds of sal ammoniac with one hundred pounds of borings of iron. A little sulphur is also used sometimes to quicken the progress of corrosion, but is not absolutely necessary. When the workman is about to make the joint, he puts a sufficient quantity of the above into a small tub and applies to it a quantity of water; he then puts some hemp into the tub which he works round in the mixture so as to make it take up as much of the iron and sal ammoniac as he can, and he caulks this into the joint. The salt, by means of the water, acts upon and oxydizes the iron, and in a short time the mixture becomes extremely hard and quite impervious to water; of the two plans, however, the lead has been found to answer by far the best and, with the exception of one company, is now universally in use.

According to a description of the method adopted by Philadelphia in 1819, the only difference from the above was the use of a snake or "nippers" to hold the lead, in addition to the clay recommended by Walker. This change was probably made necessary by the size of the pipe, since the first lines laid were 20 and 22 in. in diameter. Portions of the mains laid in 1819 are still in use.

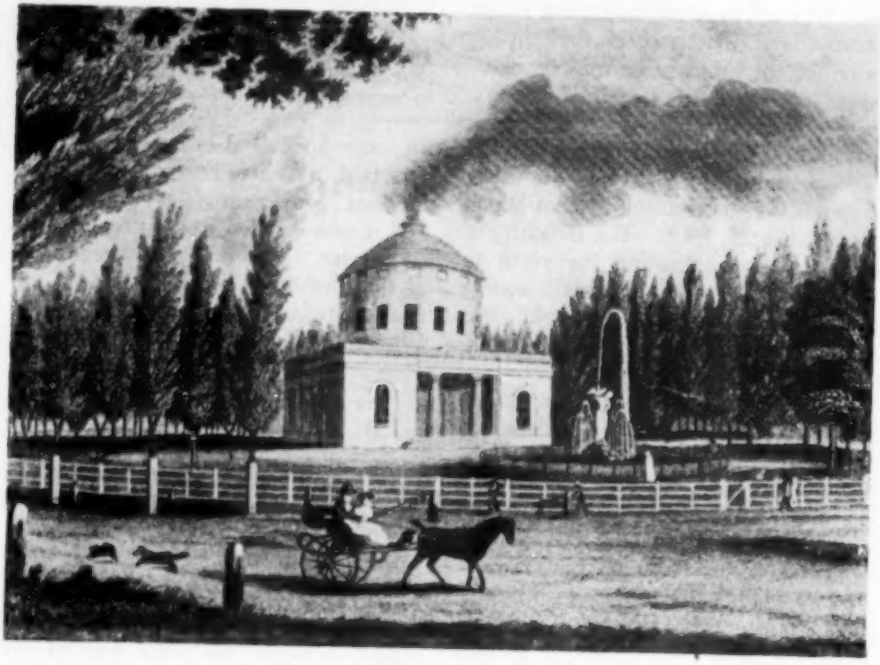

FIG. 2. Center Square Pumping Station

Pumping

The expense of keeping the old wooden pumps running and the outages due to insufficient storage caused the city to build another steam station at Fairmount, near Morris Hill, upon which storage reservoirs were constructed. These works are now part of the Aquarium, and the Art Museum

has replaced the reservoirs. The station was started in 1812 and placed in service in 1815.

The storage reservoir was so satisfactory that construction of a dam and water-driven pumps was authorized immediately. Located adjacent to the Fairmount Station, these works began operation in 1822. Additional water wheels and pumps were placed in service from time to time until 1851, when the first pump driven by a turbine was installed. In 1866 the paddle wheels were replaced by turbines. The pumps remained in use until March 1911, shortly before the filtration plants were completed.

Figure 3 is an interior view of a section of the Fairmount Water Works, showing the paddle wheels and force pumps. A section and elevation of the turbine installation are shown in Fig. 4.

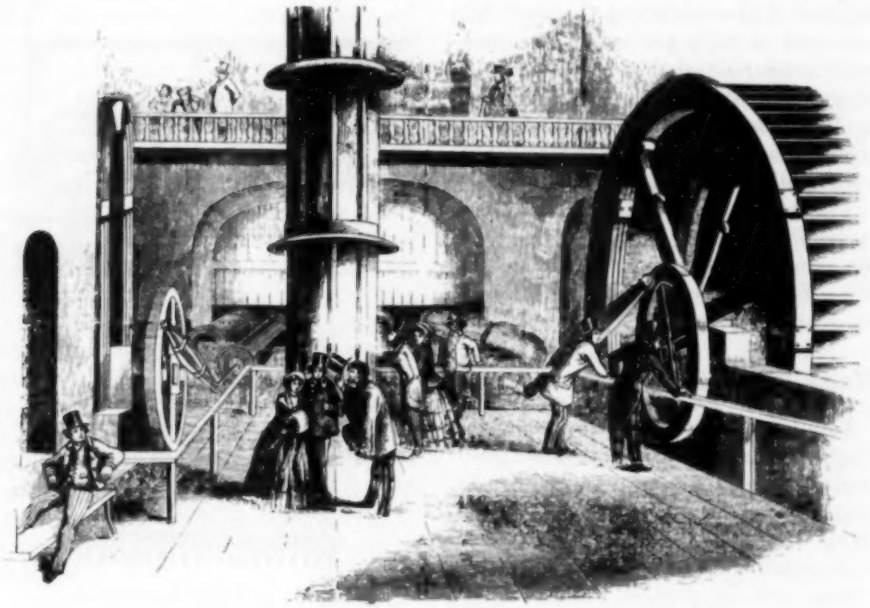

FIG. 3. Fairmount Water Works

Treatment

About 1875 work was begun on large reservoirs into which all water was to be pumped for subsidence before delivery to the distribution system. East Park Reservoir was the first and largest of these. The subsidence method of purification proved inadequate, however, and the capacity did not keep up with the demand. In 1900 construction was started on filtration works for the whole city supply, which were completed in 1912. Leakage and waste surveys were also carried out, and metering was started to reduce the high per capita consumption.

Rates and Costs

Many comparisons can be made in reviewing the annual reports. Two of the most interesting concern water charges and the cost of pipe.

The charge for a dwelling in 1801

was $5.00 per year. The minimum charge on schedule rates for a dwelling in 1948 was also $5.00, although this was raised to $6.25 in 1949. In 1948, however, only a kitchen sink and plain faucet were allowed for the minimum charge.

According to an 1801 report, the cost, per foot, of 6-in. cast-iron pipe delivered was estimated at $1.53; of filling up, including lead joints, 8¢; of digging the pipe trench and filling up, 7¢; and of labor in laying the pipe, 3¢; or a total of $1.71 per foot. The most remarkable part of this estimate is the 7¢ per foot of trench. Pipes were to be 3 ft. deep. Even at 93¢ a day for twelve hours, a man still had to move a lot of dirt in an hour.

The actual cost of 6-in. iron pipes in 1819 was $1.10 per foot. In 1938 the same pipe cost only $0.79 and in 1950, $1.27. No record was kept of the cost of laying.

Waste Disposal Problems

From the beginning the problem of supplying the city with water has been made difficult mainly by the failure to care properly for the disposal of the waste products. After the excellent well supply was ruined by disposal of wastes into the ground, the river supply was likewise contaminated. In 1828 the state legislature passed the first law to protect the Schuylkill, but neither it nor succeeding legislation were sufficient to overcome public resistance and force the citizens to provide adequate disposal.

In 1872 Frederick Graff Jr., then chief engineer of the water works, wrote in his annual report:

> There have not been any reasonable complaints as to the quality of the water delivered from any of the works during the season. In the early part of the year, the City Solicitor commenced proceedings against some of the mill owners at Manayunk to restrain them from all unnecessary discharge of foul matter into the Schuylkill; but Councils subsequently directed these proceedings to be suspended, and therefore the parties in question are still permitted (by the virtual sanction of Councils) to violate all the laws of justice and the common decencies of life by continuing to discharge foul matter into the river wantonly and unnecessarily.

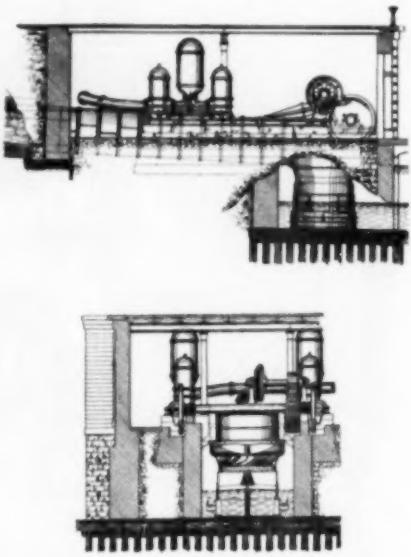

FIG. 4. Turbine Installation

It is much to be regretted that the measures provided for such cases by the wisdom of the State Legislature should not be rigidly enforced.

During the next decade the first large interceptor sewer was constructed, to bring all sewage from the city line to a point below the Fairmount Dam. Today more emphasis is being put on waste disposal and less on water supplies from relatively uninhabited areas.

Philadelphia Improvement Program

By Myron G. Mansfield

A paper presented on May 23, 1950, at the Annual Conference, Philadelphia, by Myron G. Mansfield, Vice-Pres., Morris Knowles, Inc., Pittsburgh, Pa.

DURING the past 30 years numerous plans have been developed for improving Philadelphia's water supply system. These programs involved not only the continuation of the present or nearby sources, but the utilization of an upland source of supply as well. One feature common to all plans was the necessity for some degree of treatment of the raw water to render it safe and satisfactory for domestic and industrial uses. The main objections to the plans for continued use of the present sources have been the high bacterial content of the raw water, the taste, odor and color of the finished product, and the hardness of the Schuylkill River supply. Various plans for upland sources of supply also provided for treatment but to a much lesser degree than is presently required.

Approximately one-half of the raw-water supply is now obtained from each of two sources, the Delaware and Schuylkill Rivers. Treatment facilities for the Delaware source consist of prefilters and slow sand filters, with a nominal capacity of 200 mgd., located at the Torresdale plant. Schuylkill water is treated at four plants, which also have a total nominal capacity of 200 mgd. The latter installations comprise prefilters and rapid and slow sand filters at the Queen Lane plant; rapid and slow sand filters at the Belmont plant; and slow sand filters at the Upper and Lower Roxborough plants. All plants have presettling reservoirs, and raw water is supplied by four pumping stations. Filtered water is delivered by gravity or pumping to ten storage reservoirs or basins, having a combined capacity of approximately 900 mil.gal., and to the distribution system, composed of approximately 2,650 miles of mains up to 93 in. in diameter. The distribution system is divided into ten separate districts, with variations in elevation of approximately 400 ft.

Nature of Program

The present water supply improvement program was originally planned in 1940 and, unlike many others, was actually started in that year. In general, it provided for complete rehabilitation of the various treatment plants, with adequate means for combating tastes, odors and color in the finished product; modern chlorination facilities at all treatment plants and distribution reservoirs; major improvements and additional pumping capacity at the various raw-water stations, including the electrification of the Queen Lane station; the electrification of the Lardners Point filtered-water pumping station, including additional pumping capacity; the construction of a new filtered-water pumping station at Tor-

resdale; and various new booster stations and additional pumping equipment at existing stations. The program also involved major extensions, replacements and improvements to the distribution system, to provide more reliable service, better pressures in various districts and economies in operation. The improvements were planned to meet estimated 1965 requirements.

Much investigation and study were needed for the proposed program, including experimental data from model plants, on the basis of which detailed designs and plans could be prepared. Such data were particularly necessary to provide maximum economy of construction and operation in relation to present facilities, low first cost and ability to fit into the existing system with a minimum interruption of service.

Because of their urgency, many of the larger projects were started first, and, due to their magnitude, construction plans and specifications were not completed in time to secure bids before the inauguration of the priority requirements for construction materials in October 1941. At that time contracts had been awarded for filtered-water pumping equipment at Torresdale and Lardners Point; for the Belmont 48-in. raw-water lines; for the Queen Lane presedimentation reservoir flume; and for distribution system improvements totaling in excess of $1,000,000. On account of the defense program, it became necessary to defer practically all work on improvements to the purification plants, although pumping station improvements did progress, at a slow rate, substantially in accordance with the 1940 program. Many temporary and costly measures had to be taken, however, in order to maintain an adequate and satisfactory supply in the face of the additional load placed upon the system by industry.

The waters of both the Delaware and Schuylkill Rivers, as obtained at the intakes of the filter plants, have for many years been polluted to a greater degree than the raw water of other large cities and materially in excess of the limits recommended by the U.S. Public Health Service for supplies to filter plants of conventional design. Pollution is largely due to the discharge of sewage and industrial wastes from numerous municipalities and industries above Philadelphia, in addition to acid drainage and culm from mining operations on the Schuylkill River. The pollution at the intake is less for the Delaware River than for the Schuylkill.

The increase in pollution in both rivers over the last 25 years, particularly during the war, and the inadequacy of the treatment plants to combat frequent tastes, odors and color in the water delivered to consumers, aroused such public sentiment that Mayor Samuel, in March 1945, appointed a water commission, representing various groups of citizens, for the purpose of again seeking a solution to Philadelphia's water supply problem. The commission was given a twofold assignment: [1] to study the question of improving the present sources of supply; and [2] to study the sources of water supply outside the city in upland and mountain regions, and to recommend the source which would best serve the city's needs.

Commission Recommendations

The commission, in turn, selected a board of consulting engineers, whose principal assignment was the study of the water supply outside of the city. Following the report of this board, the commission recommended that the city

commence immediately a program of improvements to its present water system, to be divided into three stages:

Stage A. As outlined by the Philadelphia Bureau of Water and endorsed by the city council, the present plan for the rehabilitation of the filtration, pumping and distribution systems is to be completed as rapidly as possible, with early installation of additional chemical treatment facilities at existing plants, to reduce taste, odors and color in the finished product.

Stage B. A long-range program of improvements and additions to the present water supply system is to be started after Stage *A* has been completed and its results have been carefully studied and analyzed. This program is to provide for taking a larger portion of the supply from the Delaware River and for the possible abandonment of the Schuylkill River source other than as a reserve.

Stage C. The upper Delaware River at a point known as Wallpack Bend, near Bushkill, Pa., should ultimately be developed. The commission commented that an upland supply would be a great improvement over the present sources or any other considered. But the delays incident to developing such a source, interstate complications, possible legal obstacles and the large capital outlay required caused the commission to recommend, for the present, that improvements be made in existing sources.

The Delaware River Project at Wallpack Bend provides for an average supply of 500 mgd. and involves the construction of a dam on the upper Delaware near Bushkill, a regulating reservoir in the vicinity of Warrington, Pa., and approximately 80 miles of pressure conduits to deliver water by gravity to the site of the present Queen Lane filter plant, for purification purposes. The estimated cost of this project is approximately $285,000,000.

In adopting the commission's recommendation to improve the present sources, the city government gave due consideration to the strengthening of the stream pollution laws by the Pennsylvania legislature in 1945, as well as to the appropriations made for stream clearance and the inauguration of an antipollution program by the Pennsylvania Sanitary Water Board. As an initial step in this program, all polluters were ordered to prepare plans for sewage and industrial waste treatment works according to board requirements. The New Jersey Dept. of Health issued similar orders to polluters under its jurisdiction.

Although Philadelphia has long suffered from pollution in its two rivers and has looked to the state and federal governments to clean them up, the city itself has been and is a major contributor of waste. Realizing that its own pollution abatement program should lead the way, Philadelphia has embarked upon a project for constructing sewage treatment plants, and the necessary connecting sewers and sewer extensions, estimated to cost in excess of $58,000,000. Very good progress has been made to date in connection with these improvements.

Water Quality

Satisfactory bacteriological quality of the finished water, of course, is an absolute necessity and should receive first consideration, but tastes, odors and color seem to give the most concern to the average consumer. Prior to the adoption of the present program, none of the treatment plants provided for taste, odor and corrosion control. As a result of public hearings held following the submission of the commis-

sion report and the recommendations on an upland source of supply, the mayor and city council authorized the preparation and award of contracts for taste, odor and corrosion control facilities at existing plants, including an ozonation plant at Belmont. Immediate construction and installation of these facilities was to be undertaken, even before the work on new and rehabilitated plants could be completed.

Existing conditions made taste, odor and corrosion control provisions for the Philadelphia system a difficult matter, and the problem necessarily had to be approached with caution. The complications were due to the large number of miles of mains in the distribution system; the overlapping of distribution districts, so that there is a mixing of water from the two different sources of supply and from plants with different treatment methods; and the fact that raw water is secured from the same river at different locations. As an example, in the present Queen Lane plant, studies indicated the desirability of applying chlorine at seven different points; activated carbon, at four points; ammonia, at two points; and chlorine dioxide, at a minimum of two points.

Very encouraging results have thus far been obtained with activated carbon at the various plants. This treatment has been quite successful in the removal of phenolic-like tastes from the raw water which are caused by a variety of wastes. In addition, activated carbon has tended to eliminate objectionable tastes of this type produced by chlorination, although chlorine dosages have been materially increased.

At the Belmont plant, the detention period is short and it was found difficult to control and treat the water by free residual chlorination. Consequently, ozone is now used for destroying oxidizable material in the water, the ozone oxidizing it in a manner similar to free chlorine residuals, in the few minutes of retention in contact tanks.

In compliance with the authorization of the mayor and city council, an ozone treatment plant having a capacity of 1,250 lb. per day, or 9,400 cu.ft. of ozone, has been constructed at a total cost of approximately $900,000. The plant has a capacity adequate to treat the 36 mgd. passing through the rapid sand filters. Ozone treatment is applied after the river water has gone through a presedimentation basin (with a 20-hour settling period for heavy sediment) and before coagulation chemicals are applied, except that during periods of high turbidities alum is added prior to settling. As a result, the ozonated water has averaged less than 6 ppm. turbidity each month.

The ozonation plant was placed in service in March 1949 but operated either intermittently or at reduced capacity until February 1950, when the installation of new diffuser systems, consisting of porous tubes with stainless steel fittings, was completed. Continued trouble was experienced with other diffuser systems because of the escape of excessive ozone and consequent pollution of the air. On account of these difficulties, normal operation of the plant has prevailed for but a comparatively short time. During this period the water has shown only an average ozone demand, not maximum or high, and the odors have been of mild intensity, with thresholds before ozonation averaging less than 5 per cent of the intensity recorded on certain previous dates. The comparatively low intensity of the odors present in

the water has been largely reduced in the plant.

Equipment for applying free residual chlorination to the raw water ahead of the presettling reservoir and sedimentation basins at the Queen Lane plant has not been put into operation. Therefore, results are not available to make any comparison with those from the ozone plant at Belmont, where the raw water and other main plant facilities and processes are similar to Queen Lane. For most of the time during the past two years free residual chlorination has been used in the filtered-water reservoir at Queen Lane, with dechlorination of the effluent of the basins to reduce the chlorine residual. This treatment is not, however, considered a fair test of the process.

Status of Present Program

The active water works improvement program includes all of Stage *A* and a considerable portion of Stage *B*, as recommended by the Philadelphia Water Commission. Stage *B* also provides for taking all water from the Delaware River at Torresdale, with part of the supply being conveyed by tunnel to the Queen Lane and Belmont plants for treatment. The present intakes on the Schuylkill River and the raw water pumping stations would be retained to supplement the Delaware River water in emergencies. Stage *B* also includes compulsory metering throughout the city.

This program is substantially the same as that originally adopted in 1940, in so far as pumping stations, reservoirs and treatment plants are concerned, with the addition of ozone treatment facilities at Belmont. The portion of the program for reinforcements and alterations, including the cleaning and lining of large mains and the construction of small mains in the distribution system, has been materially changed and greatly increased, however, because of the urgent needs created during the war by industry and the requirements from unprecedented housing developments thereafter.

A summary of the water supply improvements included under the present program is given below. These may be located by referring to the map in Fig. 1.

Treatment Plants

Rehabilitation of the three largest purification plants will provide improved chemical feeding, rapid-mixing facilities and modern flocculation and sedimentation basins, with mechanical slow-mixing and sludge-cleaning equipment, for adequate pretreatment of the water prior to filtration; modern rapid sand filters to replace, for the most part, the presently antiquated and inefficient rapid sand and roughing filters; suitable equipment and treatment facilities for taste, odor and color control; and modern chlorination equipment for adequate pre- and postchlorination. Double filtration of the entire supply is planned, using the existing slow sand filters, at increased rates, as final or polishing units for the effluent from the rapid sand units.

The Belmont plant will have a capacity of 72 mgd. The improvements consist of pretreatment facilities for the entire supply after it passes through the presettling reservoir; the construction of new rapid sand filters with a capacity of 36 mgd.; and the rehabilitation of the existing rapid and slow sand filters. New bottoms have already been placed in a portion of the existing rapid sand filters; surface

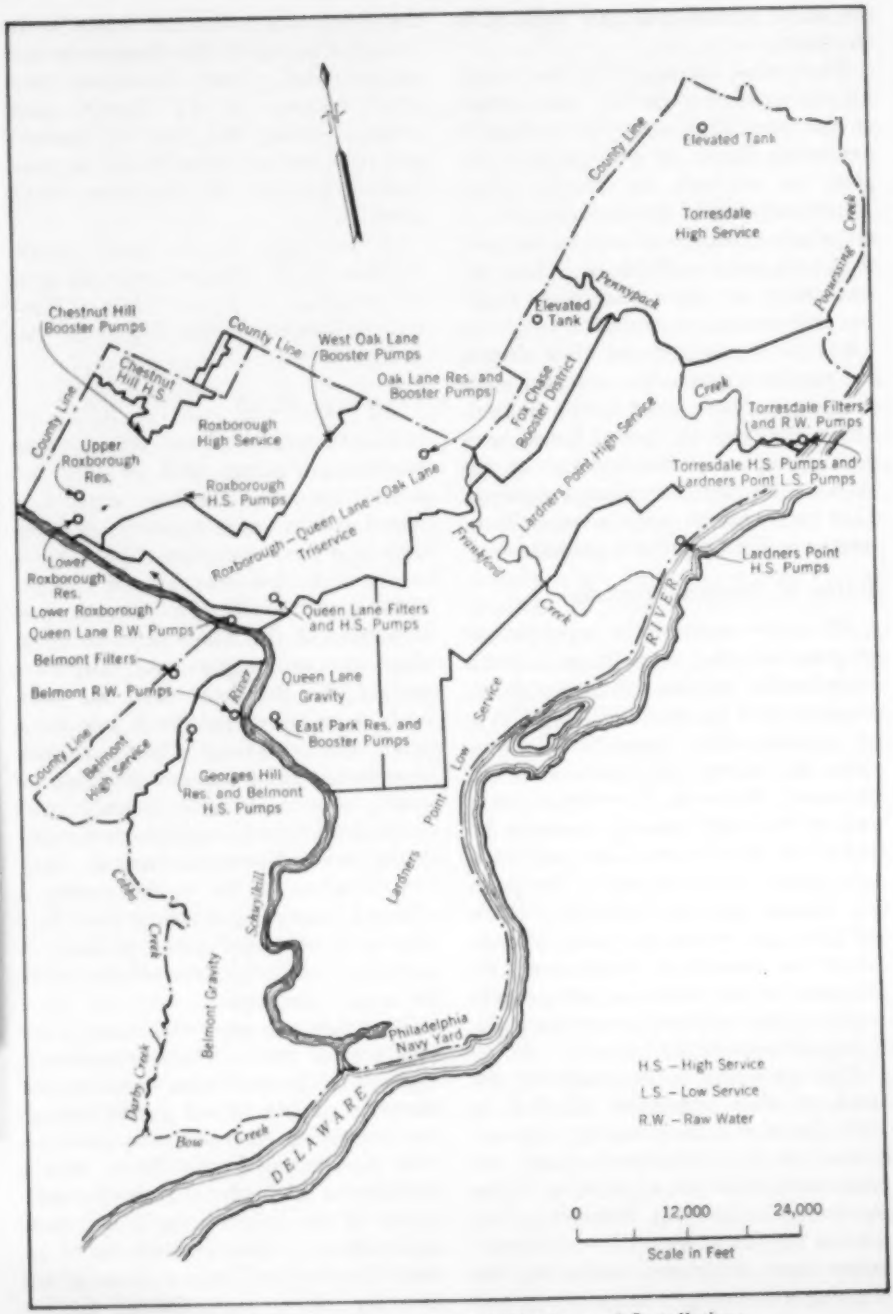

FIG. 1. Proposed Arrangement of Districts and Installations

wash has been provided for all filters; and provisions have been made for activated-carbon treatment, ozonation and corrosion control (with hexametaphosphate) of the water passing through the rapid sand filters.

The Queen Lane plant will have a capacity of 120 mgd. The improvements consist of new pretreatment facilities, with later provision for softening, for the entire supply after it passes through the presettling reservoir; reconstruction of the present rapid sand and roughing filters; and rehabilitation of the slow sand filters. The construction of the pretreatment plant and the reconstruction of the slow sand filter roofs are now in progress. Activated-carbon treatment of the water passing through the rapid sand filters, high-capacity chlorination of filtered water at the entrance to the filtered-water basins and sulfur dioxide treatment for limiting effluent chlorine residuals have already been provided. Free residual chlorination facilities and modern chemical handling and feeding equipment for treatment of the raw water at the entrance to the presettling reservoir have recently been installed.

The Torresdale plant capacity will be 270 mgd. The improvements consist of new pretreatment facilities and new rapid sand filters for the entire supply; rehabilitation of the slow sand filters; and modern chlorination facilities at the influent end of the filtered-water reservoir. Modern chemical-handling and feeding equipment, operating automatically in proportion to the flow at the entrance to the tidal basin, and pre- and postchlorination, chlorine dioxide posttreatment and corrosion control facilities have already been installed.

Studies indicated that the improvements considered desirable at the Shawmont raw-water pumping station and the Upper and Lower Roxborough filter plants, in order to continue service to districts now supplied by the latter, would be more costly than providing an equivalent supply from the Queen Lane and Torresdale plants. Consequently, it is planned to discontinue the operation of the two Roxborough plants, with a combined capacity of 20 mgd., after completion of the Queen Lane and Torresdale improvements. The 147-mil.gal. raw-water reservoir will be used for filtered-water storage to meet peak demands in the districts served. Storage for filtered water is now deficient in this section of the city. Provisions for alum coagulation of the river water before it enters the presettling reservoir and for corrosion control with hexametaphosphate have already been made.

The tidal basin at Torresdale and presettling reservoirs at other plants have been cleaned. After 50 years of operation the Queen Lane Reservoir had an accumulation of silt deposits which occupied approximately half the total storage volume.

Pumping Stations

The improvements to the Belmont raw-water pumping station include the installation of two 30-mgd. motor-driven centrifugal pumps to replace existing units; flood protection for the station; and rehabilitation of the intake structure and equipment. Sections of the two 48-in. force mains leading to the presettling reservoir have already been replaced. The total pumping capacity of this station will be 130 mgd.

The existing steam turbine-driven pumping units at the Queen Lane raw-water pumping station will be replaced

with four 40- and two 20-mgd. motor-driven centrifugal pumps having a total capacity of 200 mgd. The units will be installed in the present pumproom, while new structures for housing electrical equipment, station operators, and shop, storage and similar facilities will be built at the location of the existing boiler room. Rehabilitation of the intake structure and equipment is also included in the work contemplated. Pumping units have been delivered, and two 40-mgd. pumps have been in operation for some time in a temporary building, to facilitate repairs to and later replacement of existing equipment.

A new and modern filtered-water pumping station has been constructed and is in operation at Torresdale. It houses four 40- and two 20-mgd. motor-driven centrifugal pumps, with a total capacity of 200 mgd., for supplying water to the Lardners Point low-service and central business districts. One 6- and three 3-mgd. high-lift motor-driven centrifugal units, with a total capacity of 15 mgd., are also housed in this station to supply water to the Torresdale high-service district.

Steam pumping equipment at the Lardners Point filtered-water pumping station has already been dismantled and removed from the site. This station will have a total pumping capacity of 210 mgd., consisting of four 40- and two 25-mgd. motor-driven centrifugal units, the contract for which was awarded in 1941. Two 25-mgd. units were installed in a temporary building as soon as delivered, to replace worn-out equipment and to facilitate later installation of new units in the north section of the existing pumping station. Because of the condition of the steam equipment and the additional load placed upon the station during the war, it became necessary to replace one steam unit by the temporary installation of a 40-mgd. pump in the south enginehouse. Two 40-mgd. units permanently installed provide a present station capacity of 170 mgd.

The Lardners Point station will supply the Torresdale low-service district. Four 30-mgd. centrifugal pumps, designed for a total head of 85 ft., are in storage and will be installed on the opposite ends of the motors driving the 40-mgd. units, for delivering water from the 93-in. main into the district. Provisions for boosting the water delivered by the Torresdale station will permit dewatering and the making of needed repairs to the existing 10-ft. 6-in. low-level conduit between the Torresdale filtered-water reservoir and the Lardners Point pumping station.

Distribution Reservoirs

Facilities for automatic control of inflow and outflow water, to furnish circulation through the distribution reservoirs and automatic chlorination of all water leaving them, have been provided at East Park Reservoir and are being installed at Oak Lane Reservoir. Eventually both reservoirs will be covered.

Distribution System

Improvements in the distribution system consist of the replacement of mains which have become too small and have given trouble from breakage and corrosion; extensions to newly developed territory and to many housing projects which have been completed since the war or are now under construction; and rehabilitation of existing mains. These improvements will generally result in better pressures throughout the various districts. Approximately 4 miles of trunk mains,

48, 54 and 60 in. in diameter, have already been laid.

The existing 93-in. steel main between the Torresdale and the Lardners Point stations will be used for low-service distribution, water being supplied from Torresdale instead of Lardners Point as at present. The low-service district, which will be extended north along the Delaware River, the central business district and areas to the south now served by the Queen Lane plant and high-pressure service from Lardners Point will be supplied from the Torresdale station, with connections to East Park Reservoir.

In addition to the economies in operation due to increasing the area of the low-service district, the completed and proposed improvements will permit a greater portion of the supply to be taken from the Delaware River. They will also allow full employment of the storage available in East Park Reservoir and will make usable the improved facilities for providing service either from the Torresdale or Queen Lane plants at times of high demand or when there are operating difficulties in either system.

The program also includes booster pumping stations at Roxborough, Belmont and Oak Lane, and elevated storage for supplying high-service districts. The Fox Chase booster station has already been completed and is now in operation.

As of January 1, 1950, approximately $9,500,000 had been expended or set aside for distribution system improvements. These include approximately 172 miles of mains 6–60 in. in diameter and the cleaning and relining with cement of approximately 22 miles of 48-in. steel pipelines.

As the high-pressure fire system is maintained and operated by the Philadelphia Bureau of Water, the program includes the relining of Fairhill Reservoir, already completed, and the rehabilitation of the Fairhill and Race Street pumping stations.

Cost of Program

The magnitude and present status of the improvement program can best be illustrated by figures on estimated cost and dollar expenditure. The total estimated cost of the active program is approximately $62,000,000. Out of a total present appropriation of $26,000,000, there remained, as of April 30, 1950, an unallocated balance of $1,900,000. An additional appropriation, amounting to $12,000,000, has been made and now awaits the passage of an ordinance allocating the funds to projects next on the schedule. Additional appropriations of approximately $24,000,000 will be required to complete the present program. The schedule has necessarily been revised from time to time to meet changing conditions, such as increases in overall consumption, variations in the quality of raw water, higher demands in particular districts and a lack of funds to permit starting some of the larger projects while simultaneously carrying out smaller ones which are equally important. The last point applies particularly to the Torresdale filter plant, estimated to cost approximately $9,000,000, which is badly needed to meet present demands. The average consumption of filtered water in 1949 was 351.2 mgd., with a maximum day of 453.8.

More than $1,000,000 from the original bond issue was spent for emergency work and repairs at pumping stations and filter plants during the war, when progress on the original program was practically at a standstill.

Water Works Management and Los Angeles Progress

By Samuel B. Morris

A paper presented on May 23, 1950, at the Annual Conference, Philadelphia, by Samuel B. Morris, Gen. Mgr. & Chief Engr., Dept. of Water & Power, Los Angeles.

CALIFORNIA is a semiarid state. Virtually all rain and snow in the high mountains fall during winter and early spring, practically none during summer and autumn. On an average, 70 per cent falls in the three winter months. In the extreme northwestern part of the state, rainfall exceeds 100 in. per year. In the extreme southwestern area, the rainfall is only 2 or 3 in. per year. Los Angeles has an average of 15 in. of rain annually. Southern California, with 50 per cent of the state's population, has less than 2 per cent of the stream flow. The provision of an adequate water supply, made possible by foresighted policies developed early in its history, has been an essential factor in the development of Southern California. This paper will tell the story of the vision, faith and perseverance of the pioneers who conceived and built so well for the future. But first a brief chronicle of events is in order.

Early History

On October 8, 1542, just half a century after Columbus discovered America, the Spanish explorer, Juan Rodriquez Cabrillo, dropped anchor in San Pedro Bay, now Los Angeles Harbor. Little about this area was recorded for the next 225 years until Don Gaspar de Portola, on his march northward seeking Monterey, camped at Sycamore Grove on the banks of the Arroyo Seco ("dry creek") on August 1, 1769. The following day he and his men pitched their tents on the east bank of a clear stream which they named Rio de la Porciuncula. They observed the broad expanse of rich valley lands that could be irrigated. How long the little Indian village of Yang Na had existed no one knew. The next day they marched past the now famous La Brea pits, from whose tar so many perfectly preserved skeletons of mastodons, saber-toothed tigers, giant sloths and numerous other prehistoric animals have been excavated. The rather violent earthquakes observed by de Portola gave early warning that all engineering construction should be earthquake resistant.

On September 4, 1781, Felipe de Neve, with a detachment of soldiers bearing the banner of Spain, led a little band of 44 settlers, composed of 11 men, 11 women and 22 children, to found El Pueblo de Nuestra Sonora la Reina de Los Angeles on lands adjacent to the Rio de la Porciuncula, now the Los Angeles River. Children have continued to arrive in about this proportion, which presents to the superintendent of schools the problem of

providing four additional classrooms a day.

Of greatest value to the pueblo and its successor was the act of King Charles III of Spain—born of the custom prevailing in Spain's semiarid lands—granting to the pueblo all of the waters of the Rio de la Porciuncula. Many have been the jokes about this upside-down Los Angeles River, but it has been and still is a very valuable asset to Los Angeles.

The first settlers drew lots for ground around the plaza on which to build their adobe huts. Open ditches conveyed water to the pueblo and to the ranch lands which they irrigated. The main ditch was the Zanja Madre, and all ditches were in charge of *zanjeros* or ditch tenders. This ditch system has always been owned and operated by the pueblo, and later by the city, of Los Angeles. The ditches reached their heyday in the mid-1880's, a hundred years after the pueblo's founding. Early authors have written of the beauties of the Los Angeles of this period, its many ditches lined with trees and shrubs bearing beautiful flowers and luscious fruits.

In 1835 the Mexican Congress, succeeding to the authority of Spain, had raised the pueblo to a city (Ciudad de Los Angeles) and named it the capital of the territory which was to be lost to the forces of Gen. John C. Fremont only thirteen years later. For a brief period California was an independent state under the Bear Flag. A city council was installed January 1, 1848, and two years later the U.S. Census recorded a population of 1,610 whites, with probably about as many Indians. On April 4, 1850, the legislature, meeting in San Jose, incorporated the city of Los Angeles.

The first pipes for domestic water distribution were hollowed wooden logs authorized by the common council in 1857. Water had previously been distributed from a barrel carried by wagon and delivered to *ollas,* large earthenware jars that held 10–20 gal. of water, kept cool by evaporation through the porous clay.

Topography and Hydrology

There was trouble in maintaining diversions from the Los Angeles River. Usually a clear stream of nearly constant flow rising from the lower edge of the alluvial gravels of the San Fernando Valley, the river on occasion became a torrent of flood waters, carrying everything before it. In 1815 the river flowed westward to the sea near Playa del Rey. Ten years later it reverted to its present outlet into Los Angeles–Long Beach Harbor, 20 miles south along the coastline. The San Gabriel River has also varied its course from joining the Los Angeles River to emptying separately into Alamitos Bay, another 10 miles down the coastline. And so it has been throughout recent geologic time—these rivers have deposited eroded sands, gravels and clays more than 1,000 ft. in depth, creating the broad, gently sloping valleys that have provided ground water storage of great economic worth to Southern California.

There are approximately 2,200 square miles of inhabitable lands, mostly in valleys interspersed with hills, lying between the Sierra Madre and the Pacific Ocean. This region, roughly 40 miles wide and 60 miles long, constitutes the largest area of valley lands facing directly upon the Pacific Ocean in the entire 2,000-mile United States coastline from Canada

to Mexico. These rich lands and the superb climate have been the cause of the ever continuing migration of people from the more rugged climates of the East and Middle West.

The tributary drainage areas from the high mountains are small, extending only a few hundred square miles. The annual rainfall is only about 10–12 in. at the coastline, increasing to approximately 20 in. at the foot of the mountains and to 30 in. or more in the mountains. North and east of the mountains, the rainfall drops below 5 in. per year, creating the Mojave Desert. The map in Fig. 1 (p. 660) shows some of the principal geographic features of Southern California.

Nowhere in the United States are flood conditions so severe and the protection of life and property so expensive as in the area of metropolitan Los Angeles. The maximum recorded rainfall in Santa Anita Canyon, 20 miles from Los Angeles, is 26 in. in 24 hours, a United States record. The 6,000–10,000-ft. mountains are so precipitous and friable that erosion during one storm has amounted to as much as 100,000 cu.yd. per square mile and has averaged 50,000 cu.yd. per square mile over this entire mountain area. The debris is carried down the slopes into the valleys, where it remains deposited instead of going on to the sea.

Water Development Pioneers

By 1868 the mayor and council of Los Angeles had tired of their difficulties in providing water for the city, and on July 22 the system was leased to the Los Angeles City Water Co. for 30 years. In 1875 this company employed as its superintendent Fred Eaton, who also served as chief engineer from 1883 to 1885. He was later to become city engineer and mayor and an important figure in planning the future water supply.

A young Irishman, William Mulholland, who was to head the water system for 50 years, was given a tunnel contract in 1886 and soon thereafter was made superintendent of the Los Angeles City Water Co. Thomas Brooks joined the company in 1883 and continued to serve for 55 years in charge of water distribution. Others connected with the water company who continued in important service with the city after termination of the lease were: L. M. Anderson, Controller; James P. Vroman, Secretary; George Read, Superintendent of Meters and Services; and Fred J. Fischer, Mechanical Engineer. Brooks, Anderson and Read, all now retired, are still in good health.

To this group of far-seeing pioneers should be added William B. Mathews, Los Angeles city attorney, who later became chief counsel to the Los Angeles Water Dept., to its successor, the Dept. of Water and Power, and finally to the Metropolitan Water Dist. of Southern California. Dedication of the terminal reservoir of the Colorado River Aqueduct as Lake Mathews gives honor and recognition to his eminent services to Los Angeles. Stephen B. Robinson, who succeeded him, is still a special counsel to the department.

Others who entered the department's service and who should be mentioned are H. A. Van Norman, for many years engineer of the Los Angeles Aqueduct, who succeeded Mulholland in 1928 and became the first general manager and chief engineer of the Dept. of Water and Power in 1943; and William W. Hurlbut, who retired

as chief engineer of water works in 1945. Both of these men carried forward the high ideals and performance of William Mulholland, the first chief engineer.

At the expiration of the 30-year lease of the city's water system, there was much contention regarding its continuance. Popular demand for municipal ownership of the water works resulted in an election on August 28, 1901, at which $2,000,000 was voted, 6,284 to 1,267. This was the electorate's first important water decision. On February 6, 1902, the Los Angeles City Water Co. was purchased for $2,000,000 and the city began the direct management of its water works through the Los Angeles Water Dept., with William Mulholland as superintendent. The population of Los Angeles was then over 100,000.

Charter Provisions

Very important decisions immediately followed the resumption of municipal water distribution. The management of the water works was to be divorced from the rest of the city government and its funds were to be kept separate. The 1903 amendment to the city charter was a most vital document, providing for the successful, businesslike operation of the city's water works. Article 18, "Water, Water Rights and Water Works," read, in part:

Sec. 190. The City of Los Angeles shall continue in the ownership and enjoyment of all the rights to the water of the River Los Angeles heretofore vested in it, its predecessors or predecessor, including the Pueblo of Los Angeles, and it is hereby declared to have the full, free and exclusive right to all the water flowing in the said river at any point from its source or sources, to the intersection of said river with the southern boundary of said city, and also the ownership of and the right to develop, economize, control, use and utilize all waters flowing beneath the surface in the bed of said river at any point or points between the points of termini above named.

Sec. 191. The said city shall not convey, lease or otherwise dispose of its rights in the waters of said River Los Angeles, or any part thereof, or grant or lease to any corporation or person any right or privilege to use, manage or control the said waters, or any part thereof, for any purpose, public or private. No other water or water rights now or hereafter owned by said city shall be conveyed, leased or otherwise disposed of without the assent of two-thirds of the qualified electors of said city voting upon such proposition at an election, general or special, at which such proposition shall be lawfully submitted; provided, however, that this section shall not be construed to prevent the ordinary sale and distribution, by the city, in the manner hereinafter prescribed, of the waters belonging to said city, to the inhabitants thereof or persons doing business therein for domestic and irrigating uses, and for manufacturing and business purposes, other than water power.

Sec. 192. There is hereby created, for the purpose of managing and controlling all waters and water rights that are now, or may be hereafter, owned by the City of Los Angeles, a department of said city to be known as the "Water Department," which shall be under the management and control of a Board of Water Commissioners.

(a) Said Board shall consist of five members, who shall be appointed by the Mayor, subject to confirmation by a majority of the Council. [The duties of the Board shall be] to appoint, employ and, for good cause, to remove the Superintendent of Water Works, the Water Overseer and such assistants, employees

and laborers as the Board may deem necessary; to fix their compensations, prescribe their duties and to require of any or all of them adequate bonds for the faithful performance of such duties.

The term of one member of the board was to expire each year. Water rates were to be fixed by the board, subject to approval of the city council. The charter further provided that none of the money should be used for any purpose other than the following:

First: For the necessary expenses of conducting the Water Department, of operating the water works and of making all current and ordinary extensions, betterments and repairs.

Second: For extraordinary improvements of and betterments to the property, works and systems of supply and distribution of the Water Department, including the purchase of necessary lands, water rights and other property.

Third: The payment, as above provided, of installments of interest or principal, or of interest and principal coming due upon outstanding water works bonds.

The above provisions of the city charter remain in substantial effect to this day, except that the board may, from surplus revenues, appropriate sums to the general funds of the city. In 1911 the name of the department was changed to the Department of Public Service and in 1925, to the Department of Water and Power, on the adoption of a new freeholders' charter.

First Annual Report

The first board of water commissioners was organized on February 13, 1902, pursuant to a city ordinance and prior to the charter amendment of 1903, which provided more permanent authority for the city's administration of its water works. The first annual report, covering the period February 13–December 31, 1902, contains a number of statements indicating the adoption of sound policies. One of the policies most important to this semiarid land has been the effective protection of the city's water rights. The first report states:

The Spanish and Mexican archives abound in interesting episodes, showing how highly the authorities and citizens of the Pueblo prized their water rights, how jealously they guarded them against all adverse claims, even those of adjoining missions, and how they instantly and valorously defended them against all unfriendly acts; and we, their successors in this precious and unique heritage, will do well to emulate their aggressive vigilance.

Regarding the period of private operation, the report commented:

It is well, however, to seriously consider and take to heart the unmistakable lesson taught by the whole history of this transaction, beginning with the execution of the contract in 1868 and ending with the payment of the price for the works in 1901; and that lesson is the unwisdom and the danger of yielding up for any consideration or to any person the municipal control of the waters which the city owns and has always owned.

It is not the economic theory of municipal ownership and administration of public utilities which concerns us; we are confronted with a condition and not a theory. The city owns its waters, and our experience should convince us of this generation of the farsighted wisdom of our Spanish and Mexican predecessors in holding on to their rights in the waters of the river of Los Angeles with a grip of iron.

Policies in the selection of employees were based on a firm adherence to the

principles of civil service, as set forth in these words:

The Commission, being in full accord with the provision in the Ordinance relative to the Civil Service, unanimously adopted the Civil Service principle, in so far as it could be followed with due regard for the best interest of the service; and having taken into consideration the reliability, efficiency and the experience acquired by reason of long service by those in the employ of the former Los Angeles City Water Company, it was deemed advisable to retain them in the service of the City, and few changes were made in the technical and clerical departments.

Mr. William Mulholland, the former Engineer, was retained in the capacity of Superintendent, and Mr. Fred Eaton was employed as Consulting Engineer for a period of three months. The engineering and general superintendency being under the direction of Mr. William Mulholland, other necessary changes were mostly made by the promotion of those in the service who have proved their capacity and efficiency. In all changes and new appointments the best interest of the Department alone has been considered.

These principles are continued in the present city charter. There are only five positions exempt from civil service: the general manager and chief engineer, the chief engineer of water works and deputy general manager, the chief electrical engineer and deputy general manager, the controller, and the cashier, and attorneys serving under the elected city attorney.

In contrast to the fact that many cities even to this day are still arguing over the wisdom of installing water meters, the 1902 report states:

The impending shortage of the water supply last summer was a subject of the deepest concern. This problem was, however, most fortunately solved by the perfectly equitable and rational method of applying meters. The Board met with much unreasonable opposition in the application of this measure, and it is surprising how forgetful people are of the theory on which all assessments are made for the maintenance of government for all manner of public service. The object is to so levy on each individual as to have him pay for the share of those benefits he receives. This is precisely what a meter is intended to accomplish in the case of that greatest of public utilities, a water supply.

Measured by its results, the meter system, even on the limited scale to which it has been tried, has proved an unqualified success, its influence having been extended far beyond the restraint it put on the services to which meters were applied, by reason of the agitation their use invoked, calling attention in an effective manner to the extravagant use and in many cases the most reckless waste of water. The effect of the education cannot be overestimated. The application of the meters has caused a saving of nearly 3 mgd. of water, an amount which, if figured at the rate of even the common price of irrigating water, . . . would amount to $231,000.

The Board feels gratified to state that the opposition to meters has nearly subsided and that the system is accepted by most of our citizens with grace, and it is to be hoped that the consumers will receive their reward in a much improved service and a further reduction of water rates as soon as the financial condition will permit.

Los Angeles Aqueduct

The extreme drought of the eleven-year period, 1893–1904, and the rapid growth of Los Angeles, brought stark realization of the necessity for procuring a water supply to supplement the Los Angeles River. Other local sup-

plies were found insufficient and had already been largely put to use. Superintendent Mulholland and J. B. Lippincott, consulting engineer, had made a full report in 1905 on all possible opportunities of gaining adequate water supplies from Southern California areas. The report concluded, in part, that "any waters to the extent of 500 cfs. that can be obtained in addition to those actually needed for domestic consumption, could be used for the development of highly productive citrus foothill lands immediately surrounding the city. Doubtless these lands, if irrigated, would soon become densely populated suburban additions to a Greater Los Angeles."

Fred Eaton, former chief engineer of the Los Angeles City Water Co., former city engineer and mayor of Los Angeles, was familiar with the Owens River, draining the east side of the Sierra Nevada and wasting into saline Owens Lake. Eaton suggested to the board that the Owens River would be a good source of water supply for Los Angeles. Without any public announcement, Supt. Mulholland accompanied Eaton to the Owens River in September 1904. On his return Mulholland reported to the board that "an abundance of pure water for the city's needs could be procured in the Owens River Valley, and that its conveyance to the city was entirely practicable." After preliminary surveys and estimates, the board authorized the pur-

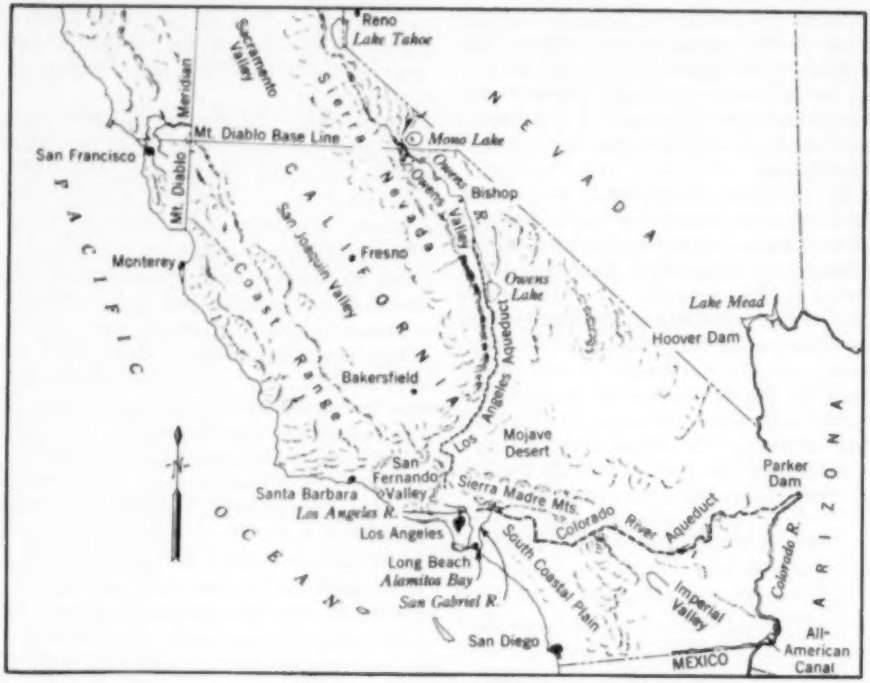

FIG. 1. Southern California

chase of the necessary riparian lands and rights. Once these rights had been optioned, there was a public announcement of the proposed project, the estimated cost of which was nearly $25,000,000. Public endorsement was immediate and the first bond issue was carried by a vote of 10,787 for and only 755 against.

A separate organization was set up under the board of public works for the design and construction of the Los Angeles Aqueduct to tap the Owens River nearly 250 miles away (*see* Fig. 1). Mulholland was made chief engineer, J. B. Lippincott, assistant chief engineer and E. F. Scattergood, consulting electrical engineer and later chief electrical engineer.

For final review of aqueduct plans, the board retained three outstanding consulting engineers—John R. Freeman, the most eminent consulting engineer of his time; Frederic P. Stearns of Boston; and James D. Schuyler, the leading hydraulic engineer in the West.

Municipal Light and Power

With an opportunity for obtaining more than 100,000 kw. of hydroelectric power from the fall of the waters of the Los Angeles Aqueduct, the board decided to develop this power and distribute it directly to the people in the same manner as water was being sold to the individual customer. The board was fortunate in the selection of E. F. Scattergood, previously mentioned, as head of the power system. William F. Durand, Harris J. Ryan and O. H. Ensign were named consulting engineers on power development.

Scattergood was a man of clear vision, great managerial capacity and indefatigable energy and tenacity. Under his leadership, the nation's largest municipally owned power system was built, bringing light and power to Los Angeles at rates among the lowest in the United States. The department's hydro and steam generating capacity now exceeds 1,000,000 kw.

Water Rights and Policies

While construction of the aqueduct was under way, several important decisions were taken. Aqueduct water was to be made available only within Los Angeles. Areas outside the city desiring to obtain a water supply from it were frankly told that they would have to be annexed in order to do so.

The largest of these areas was the San Fernando Valley, overlying the ground water which forms the Los Angeles River. The state supreme court had upheld Los Angeles' superior rights to all of the waters of the Los Angeles River, both surface and underground. Engineers pointed out the desirability of furnishing water at low cost for the irrigation of the otherwise dry lands of the San Fernando Valley. They forecast that 30 per cent of this water would, as the result of deep percolation, later join the rising waters of the Los Angeles River. Accordingly, the San Fernando Valley was annexed to Los Angeles on May 22, 1915.

Los Angeles, which had an area of 43.26 square miles and a population of 101,454 in 1900, has grown to an area of 453 square miles and a population of 2,000,000. With the exception of the annexation of San Pedro and Wilmington, to gain the improvement of Los Angeles Harbor, it is believed that the purpose of all other annexations has been to obtain a water supply. Irrigation of the lands of the San Fernando Valley has added materially

to the flow of the Los Angeles River. This area is now being rapidly subdivided for homes and industry.

Recurrence of Drought

Severe drought conditions in the 1920's again pointed to the necessity of adding to the water supply. During the next decade rights were acquired and works constructed which diverted streams of the Mono Basin into the headwaters of Owens River and thence into the Los Angeles Aqueduct. The aqueduct when completed in 1913 had a capacity of 400 cfs., which has since been increased to 480 cfs. With outages for maintenance, an average annual flow of 446 cfs. is maintained, which, supplemented by local supplies, is sufficient for 2,000,000 people.

Colorado River Projects

Only ten years after the completion of the aqueduct, Mulholland was again seeking additional water supplies for Los Angeles. His surveys indicated the practicability of bringing in 1,500 cfs. of Colorado River water, by a 1,600-ft. pump lift and a 300-mile aqueduct, to take care of the future growth of Los Angeles. Filings on 1,500 cfs. were made with the California Div. of Water Resources in 1924.

California interests were already seeking construction of Hoover Dam on the Colorado River for flood protection, silt control and irrigation of the Imperial Valley, and for the production of more than 1,000,000 kw. of hydroelectric power. Thus, domestic water supply was added to this first great multiple-purpose water project. The construction of Hoover Dam was fought by other Colorado Basin states, which feared that California would obtain a first right to the full flow of the river. The Colorado River Compact had been signed in 1922 by representatives of the seven states concerned and by Secretary of Commerce Herbert Hoover, representing the United States. Arizona, however, refused to ratify the compact until 1944, 22 years later.

It took a strong supporting organization to educate the people of Southern California to the necessity for Hoover Dam, the All-American Canal to irrigate the Imperial and Coachella Valleys, and the Colorado River Aqueduct to bring domestic water to the thirteen cities that had banded together to form the Metropolitan Water Dist. of Southern California. Representatives of the Los Angeles Dept. of Water and Power were active in the formation of citizen organizations to conduct educational programs and to campaign at home, in Washington and in Sacramento. The Boulder Dam Assn. was successful, after eight long years, in securing the adoption of the Boulder Canyon Project Act, under which Hoover Dam and the All-American Canal were built. The Colorado River Aqueduct Assn. fostered the Metropolitan Water Dist. Act, which was adopted after a strong fight in two sessions of the California legislature. Then followed successful campaigns for the formation of the Metropolitan Water Dist. of Southern California and adoption at the polls of a $220,000,000 bond issue to construct the Colorado River Aqueduct.

The 300-mile Colorado River Aqueduct, with a capacity of more than 1 bil.gal. per day, was completed in 1941. Since then the original thirteen member cities have been increased

by annexation to a total of 28 communities, with a population of more than 3,500,000, which obtains all or a portion of its water supply from the Colorado River. Combined with local supplies and the Los Angeles Aqueduct, there is water and carrying capacity for more than 8,000,000 people.

With works constructed for an additional population of more than 4,000,000, it is believed that Los Angeles and the other member cities of the Metropolitan Water Dist. have afforded a water supply for the greatest increase in population of any American metropolitan area. Confidence in the sufficiency of this large water supply had lulled the people of Los Angeles into a feeling of security and complacency. Suddenly they were awakened by the efforts of Arizona to secure congressional adoption of the Central Arizona Project. This project would divert water from the Colorado River and deprive California agencies of their full rights to water which was relied on when works were constructed and contracts for delivery of water and power were made with the United States government. Consequently, Los Angeles management has been forced to aid in the organization of a citizen group to carry on an educational campaign and to be active in the halls of Congress to protect California's rights to Colorado River water.

Functioning of Department

With adequate water and power supplies, and the well earned reputation of never being short of either, the Dept. of Water and Power expends money and effort in promoting greater use of its services and in attracting to Los Angeles the industries so necessary to the employment of the millions who go there and so essential to the economy of the metropolitan area.

The magnitude of the rapid expansion of population—made possible by an adequate supply and distribution of water—is brought into clear focus by the following statistics: In the decade 1940–50 the population of Los Angeles City increased by more than 500,000, equivalent to that of Cincinnati; Los Angeles County gained more than 1,250,000 people, equivalent to the population of Boston and Milwaukee combined; and the population of California increased by nearly 4,000,000, equivalent to that of Missouri.

All services have been provided for this tremendous increase in population. A comparable increase in industry is vital to the economy of the region. Fortunately, Los Angeles has become a metropolitan manufacturing center of wider diversity than any other American city. Ample water and power at low rates have been the most important factors in this development—dramatic proof that the early pioneers planned wisely and built solidly to assure the future of Los Angeles, now the metropolis of the Pacific Coast.

The water works management of Los Angeles has, ever since the founding of the city in 1781, been conscious of the need for zealously guarding its water rights in this semiarid land and, since 1900, of the necessity for planning far into the future to provide a water supply for the rapidly growing community. The vagaries of climate, with six rainless months every year and 11–28 years of extreme drought followed by years of floods and heavy runoff, have been dramatized by department officials and community organizations in order to educate the new generations of the expanding pop-

ulation to the paramount need of an adequate water supply for population and industry.

Realizing the importance of water, the framers of the city charter saw the need to provide for competent, technically skilled and businesslike administration of the water works. The Board of Water and Power Commissioners must appoint as general manager and chief engineer a man of broad experience in hydraulic and electrical engineering. He, two deputies, the auditor, cashier and attorneys are exempt from civil service. All other employees are selected through civil service and appointed by the general manager. In this manner, long career service is customary and appointments are free from politics. Proper accounting is required, with water funds separated from power funds and from other funds of the city.

The department fixes its own water rates, subject to approval by the city council. All services have been metered since 1906. All positions are defined and salaries are fixed by the Board of Water and Power Commissioners. The department has pioneered in financing through the issuance of revenue bonds. In 1946 a charter amendment was adopted under which it is provided that no ad valorem bonds will be issued but rather revenue bonds may be authorized by the board, subject to veto by the city council or the mayor or by popular vote through referendum. The council may override a veto by the mayor, and a popular vote may be called for by the board to nullify adverse action by the city council. Since the war $20,000,000 worth of revenue bonds have been sold or authorized for capital improvements for water and $59,000,000 for power.

The department pays for services rendered it by the city and charges the city for water and fire hydrant service. Currently the department is paying 5 per cent of its gross revenue to the general city funds. Accounts are audited annually by an outside firm of public accountants. The charter requires that at least once in ten years there be a survey of the business practices of the department by a firm of industrial engineers.

The present management of the department recognizes the firm foundation for successful public ownership of the city's most essential utilities which was laid down by the wisdom and foresight of the pioneer civic leaders and the early commissioners, management, engineers and lawyers of the department. Following the example of such splendid leadership in the past, the department continues to seek the protection and improvement of the city's water and power resources, so that the millions of people now served and the millions attracted to the area in the future will never lack plenty of pure water and electrical energy at the lowest reasonable rates.

William Mulholland, first head of the department, when asking citizens to vote bonds for the Los Angeles Aqueduct, warned: "If you don't build it, you won't need it." These enduring words have been the guide and beacon to the management of the Los Angeles Dept. of Water and Power.

Status of Water Authorities in Pennsylvania

By Francis S. Friel

A paper presented on May 23, 1950, at the Annual Conference, Philadelphia, by Francis S. Friel, Pres., Albright & Friel, Inc., Philadelphia.

THIS paper contains an analysis of what has been accomplished by water authorities, primarily in Pennsylvania. It seems desirable at the start to outline the background, the beginnings, the purposes and the growth of water authorities and the type of business structure which forms part of such an organization. Much of the statistical material presented was taken from *The Authority*, a publication of the Pennsylvania Municipal Authorities Assn.

It has been a common experience for communities to find that vitally urgent financing was impossible under existing provisions of law. In many communities, sound, aggressive business management or practices could not be followed within the framework of the existing municipal government. Furthermore, many projects could be carried out more naturally and economically if the areas involved were determined by geographical and topographical considerations rather than by municipal boundaries. These conditions prompted the formation of authorities. In some communities, the desire of the people to own and operate, improve or extend the local water system has been the motivating factor in the purchase of a privately owned system.

The existence of these conditions has resulted in the formation of utility districts, improvement districts, sanitary districts and sanitary commissions. These agencies have been established in various ways, the financing being set up according to various plans and the management selected by different means. Limitations on areas of service or operation vary from the strictly local to the metropolitan and regional.

The authority scheme is legally available, with limitations, to municipalities or regions in a number of states, but it is principally in Pennsylvania that the rapid development of the authority has taken place, probably because of the broad powers contained in the Pennsylvania authorities act.

The first municipal authorities act in Pennsylvania, approved June 28, 1935, did not provide for water projects although "sewers, sewer systems [and] sewage treatment works" were included. The amendments of May 20, 1937, included "water supply works," but it was not until the amendments of May 17, 1939, that "acquiring, holding, constructing, improving, maintaining and operating, owning, leasing . . . water works, water supply works [and] water distribution systems" was authorized. Further amendments were enacted in 1943, and the entire act was superseded by the Municipalities Act of May 2, 1945, which substantially retained the provisions of the earlier act with its amendments.

Growth of Water Authorities

Six authorities were incorporated in 1935 and 1936, before water works authorities were made legal, and 22 more were incorporated in 1937 and 1938. The first water authority projects were not organized until 1939, however. By the end of 1948, 59 water authorities were operating, and in May 1950 the total had reached 71. Additional acquisitions are contemplated by authorities in 1950, one of which, when completed, will serve practically an entire county in the western part of Pennsylvania. Table 1 shows the growth of water authorities since 1939.

Of the 39 water authorities operating at the end of 1944, 28 had purchased privately owned water systems, 3 had acquired water systems from the parent municipality and 8 had built new systems. The 1943 amendments to the act stipulated that Pennsylvania Public Utilities Commission approval must be obtained before an authority could acquire a private water company. Since 1943, 9 water companies have been so acquired, as compared with the acquisition of 10 municipal systems, while one new system has been constructed during this seven-year period.

The population served by authorities has varied widely. Bethlehem and Chester authorities, established in 1939, each serve populations of approximately 60,000 to 100,000, whereas the Penn Township Authority, which was organized in 1941, serves a population of about 700. In 1948 the Allentown authority was set up for a population of more than 100,000. Some indication of the size distribution of the 59 water authorities operating in Pennsylvania at the end of 1948 may be obtained from Table 2, which classifies them by annual revenue. A classification by type of authority is given in Table 3.

Of the 59 water authorities in 1948, 37 purchased their systems from privately owned water companies, 14 acquired their systems from the parent municipality and 8 constructed their own systems.

TABLE 1

Growth of Water Authorities in Pennsylvania

Year	No. of Authorities		Total Cost of Initial Projects $	Population Served	No. of Customers	Total Assets (Dec. 31) $
	New	Total				
1939	3	3	10,502,669			
1940	10	13	7,986,946			
1941	12	25	6,318,360			
1942	8	33	8,141,766			
1943	6	39	8,475,000			53,841,768
1944	0	39			145,000	
1945	3	42		814,464	154,945	55,870,801
1946	5	46*	14,300,000	1,091,553	203,002	71,824,738
1947	7	53	8,700,000	1,174,481	225,886	85,306,496
1948	6	59		1,310,052	262,256	101,288,529
1949	8	67				
1950	4†	71†				

* Ross Township Authority, organized in 1941, was taken over by Westview, so that net increase in 1946 was 4.
† As of May 1950.

Tables 4–6 give comparative statistics on the distribution of capital, consumers and sales among municipal, private and authority water systems.

Powers of Authorities

J. R. Hoffert (1) has termed the authority "an agency through which a government may provide needed services and facilities for its people upon a self-liquidating basis, in the manner of private industry and without obligating the government." Another definition is the 1933 description of the Tennessee Valley Authority: "A corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise."

An authority may file liens for debts owed; has the power of eminent domain but may not acquire a water works or other system by condemnation; can sue and be sued; can issue revenue bonds but may not obligate the municipality. The life of an authority in Pennsylvania is limited to 50 years, while bond issues are limited to 40 years, with maturity of refunding bonds restricted to the life of the authority. At the termination of the life of the authority, its property may revert to the municipality or municipalities which incorporated it. An authority may engage in multiple projects, although if the service area includes more than one municipality, the revenues from one project may not be expended on any other. An interesting *carte blanche* is contained in the 1945 act, the authority being permitted "to do all acts and things necessary or convenient for the promotion of its business and the general welfare of the authority; and to carry out the powers granted to it by this Act or any other Act."

Authorities have been given the power to assess benefited properties for the cost of improvements in proportion to the benefits received. In this respect, they have an advantage over private companies.

TABLE 2

Classification by Annual Revenue

Annual Revenue $	No. of Authorities
over 1,000,000	2
500,000–1,000,000	4
250,000– 500,000	5
100,000– 250,000	9
50,000– 100,000	13
25,000– 50,000	7
10,000– 25,000	11
under 10,000	8
Total	59

TABLE 3

Type of Authority

Type	No.
County	1
Joint	1
Borough	37
Third-class city	8
First-class township	2
Second-class township	10
Total	59

The authority must establish a rate structure so that it will be entirely self-supporting from revenues or rentals. It should have no other source of income and may not be a parasite on any municipal funds, except possibly when a system is leased back to the municipality for operation. On the other hand, the authority cannot be deprived of its revenues to carry out other municipal functions.

Advantages of Authorities

It is not always easy for elected municipal officials to attract and hold the personnel required to manage successfully a large public undertaking such as a water plant, but a high level of

management is usually achieved by the authority if the cooperation of the consulting engineer is obtained and a provision is incorporated in the indenture requiring control on the part of the consulting engineer.

Municipal bonds are secured by the credit of the municipality, and the standing of the entire community is the broad basis upon which the bonds are rated by purchasers. The ability of the community to pay the carrying charges on the project is important for an authority as well, but of equal importance is the ability of management to make a success of the project; these requirements are identical to those applicable to all private utilities.

In an authority, operation, accounting and financing are separate from other municipal activities and can be carried on without interference or interruption.

The cost of water service under authority operation in Pennsylvania has been analyzed for 32 authorities which took over existing systems prior to 1945. Of this number, 24 retained the same rate base as under the previous private or municipal management, 5 lowered rates and 3 increased them.

In Pennsylvania, the authority is practically master of its own rate schedule. It may change rates in accordance with revenue requirements, and its rates are subject to review only by the Court of Common Pleas, which has exclusive jurisdiction to determine their reasonableness and uniformity.

In certain respects, authority operation has a cost advantage over municipal ownership. Payment for services for all public purposes, such as fire protection, schools and public buildings, is required by the authority. At the same time, all properties owned by

TABLE 4

Distribution of Capital Among Pennsylvania Water Works, by Ownership

Year	Total Systems Reporting	Private	Municipal and Authority	Authority	Capital			
					Total $	Private	Municipal and Authority	Authority
		per cent				*per cent*		
1932					423,200,445	55	45	0
1933					425,407,199	55	45	0
1934					431,472,966	55	45	0
1935					437,077,862	55	45	0
1936					441,157,684	54	46	0
1937					434,247,464	56	44	0
1938					434,467,798	56	44	0
1939	660	65	35	0.5	461,468,774	54	46	
1940	663	64	36	2.0	465,485,072	51	49	
1941	657	63	37	3.8	467,510,658	50	50	
1942	680	63	37	4.9	474,047,611	49	51	
1943	689	60	40	5.7	498,024,053	46	54	10.8
1944	686	60	40	5.7	492,420,528	45	55	
1945	723	57	43	5.8	503,544,699	45	55	11.1
1946	730	56	44	6.3	516,810,580	42	58	13.9
1947	734	56	44	7.2	531,381,148	42	58	19.0

the authority and "used exclusively for public purposes" are exempt from taxation. In addition, authorities have freedom from bond interest taxes, bond or security issuance taxes, federal and state income taxes on net earnings, and also social security taxes. Management costs are low since board members usually receive small remuneration, probably because authorities are generally looked upon as quasimunicipal agencies and persons who accept membership on the boards do so with the thought of rendering some service to the community. In 1945 one out of eight authorities paid board members in excess of $250 per year, and 48 per cent paid no salaries to board members.

Municipal water works in Pennsylvania in 1944 paid total taxes of less than $100,000, amounting to less than 0.4 per cent of gross revenues. These taxes were chiefly on real estate not used in the public service and on liquid fuels. On the other hand, free water service and like contributions to municipalities amounted to 4 per cent of the gross revenues, and, of those municipalities allowed to do so, 57 per cent diverted funds for other municipal purposes. The diversions amounted to 13 per cent of the gross revenues of all municipal water works.

Summarizing the conditions in Pennsylvania, it appears that where the water systems are municipally owned, the local government has taken about 4 per cent of the gross revenue in free service and 13 per cent in diverted funds, a total of 17 per cent. Nothing has passed to state or federal governments. Since it is exempt from taxation and free service and is forbidden to divert funds, the creation of an authority, without a change in rate schedules, generally increases the operating reve-

TABLE 5

Distribution of Consumers and Sales Among Pennsylvania Water Works, by Ownership

Year	Consumers				Sales			
	Total	Private	Municipal and Authority	Authority	Total $	Private	Municipal and Authority	Authority
		per cent				*per cent*		
1932	1,653,539	47	53	0	38,947,292	60	40	0
1933	1,655,911	46	54	0	36,725,942	59	41	0
1934	1,665,807	46	54	0	38,670,760	60	40	0
1935	1,685,419	46	54	0	40,243,454	59	41	0
1936	1,730,026	45	55	0	41,232,031	56	44	0
1937	1,726,507	45	55	0	41,217,022	56	44	0
1938	1,725,559	45	55	0	39,363,745	57	43	0
1939	1,755,388	45	55		41,097,616	56	44	
1940	1,779,811	43	57		42,159,551	54	46	
1941	1,785,518	43	57		44,090,367	54	46	
1942	1,795,878	42	58		45,420,038	53	47	
1943	1,827,204	39	61		44,990,291	52	48	10.2
1944	1,819,165	39	61	8.0	47,924,333	49	51	9.9
1945	1,833,170	39	61	8.5	48,185,867	49	51	10.8
1946	1,862,991	37	63	10.9	49,480,605	47	53	12.5
1947	1,905,837	37	63	13.8	52,397,787	45	55	15.0

nue, before debt service. If a municipality which has established an authority previously diverted funds and received free service, however, it must now raise money through taxes or otherwise to pay for water service and to make up for the loss of diverted funds.

Disadvantages

There are three chief objections to authorities: [1] they multiply the number of governmental units, disperse responsibility and confuse the public; [2] interest rates on authority bonds are higher than on municipal general-obligation bonds; and [3] expenses are higher than they would be if municipally managed. The second of these objections appears to have substantial foundation, but the increased interest rates seem to be justified in view of the advantages of freedom of financing and refinancing. Once a property is acquired or constructed, only additions will need to be financed.

Financial Position

Generally speaking, the bonds issued by a water authority have represented the total value or cost of the utility, particularly where the system was constructed or purchased from a private company. The only exception is the authority to which the municipally owned plant has been turned over without cost, perhaps for the purpose of having the authority make extensions and improvements. Under the law, at the end of the 50-year life of the authority all bonds must be amortized from revenue, and property then may revert to the municipality. Therefore, in the authority field, neglecting the questions of better and more adequate service and considering only the financial angle, the reduction of the ratio of debts to assets is one yardstick of success.

An analysis of the 42 authorities which were operating in 1945 and which have operated continuously since then (Table 7) shows that, in the three

TABLE 6

Sales per Consumer in Pennsylvania Water Works

Year	Avg. Price per 1,000 gal.—$		Sales per Consumer—$		
	Private	Municipal	Private	Municipal	Authority
1932	0.2074	0.0802	30.50	17.50	
1933	0.1911	0.1379	28.40	16.90	
1934	0.1889	0.1225	30.10	17.30	
1935	0.1796	0.1004	30.30	18.30	
1936	0.1581	0.1013	30.00	18.80	
1937	0.1552	0.1047	29.90	18.90	
1938	0.1733	0.1013	28.60	18.00	
1939	0.1630	0.1035	28.80	18.80	
1940	0.1450	0.1063	29.90	19.00	
1941	0.1390	0.1086	31.20	19.80	
1942	0.1394	0.1313	32.10	20.30	
1943	0.1314	0.1220	32.60	19.50	
1944	0.1319	0.1214	33.60	21.70	32.90
1945	0.1299	0.1394	33.20	21.90	33.60
1946	0.1365	0.1415	33.60	22.40	30.50
1947	0.1317	0.1465	33.80	24.80	34.70

TABLE 7

Financial Data on 42 Pennsylvania Water Authorities

Item	1945	1946	1947	1948
Population served	814,463	816,076	816,204	826,971
Total assets—$	55,870,801	57,493,557	61,599,475	67,941,367
Per cent of 1945		103	110	122
Bonded debt—$	42,000,000	42,095,450	42,873,450	44,734,052
Per cent of 1945		100	102	107
Total revenues—$	5,219,432	5,155,207	5,836,416	6,169,050
Per cent of 1945		99	112	118
Total expenses—$	1,945,288	2,046,293	2,315,066	2,541,864
Per cent of 1945		105	119	131
Operating income—$	3,273,453	3,112,700	3,520,148	3,605,339
Per cent of 1945		95	107	110
Per cent of:				
Bonded debt to assets	75	73	70	66
Operating income to revenue	63	60	60	58
Operating income to bonded debt	7.8	7.4	8.2	8.1

years 1945–48, there was an increase of $2,700,000, or 7 per cent, in bonded debt. Also, an increase of $600,000, or 31 per cent, in operating expense took place. In the same period, however, total assets rose $12,100,000, or 22 per cent, and operating revenue increased $950,000, or 18 per cent, resulting in an increase in operating income amounting to $330,000, or 10 per cent. The net effect was that, although the ratio of operating income to total expenses decreased slightly from 1.68 to 1.42, the ratio of operating revenue to bonded debt increased from 12.4 to 13.8 per cent and the ratio

TABLE 8

Comparison of Financial Data for Various Types of Ownership

Item	Pennsylvania (Municipal) 1944	United States* 1945		All Pa. Water Authorities			
		Municipal	Private	1945	1946	1947	1948
Assets per capita—$	60.00	56.73	59.76	68.00	66.00	73.00	77.00
Per cent of:							
Bonded debt to assets	33	38		75	74	71	63
Revenue† to assets	9.1	10.8	12.8	9.2	8.6	9.2	9.3
Operating income‡ to bonded debt	14.6	14.9		7.8	6.9	7.5	8.1
Operating income‡ to revenue†	52	51	55	63	59	58	55
Expenses per capita—$	2.59	3.02	3.48	2.39	2.32	2.79	3.25
Revenue† per capita—$	5.43	6.10	7.66	6.40	5.67	6.70	7.20
Per cent of revenue† to:							
Taxes	0.4		19.1§	0	0	0	0
Free water service	4.0		0	0	0	0	0
Fund diversion	13.0		0	0	0	0	0

* U.S. data includes approximately 400 municipally owned but only about 30 privately owned water works.
† Equals gross income.
‡ Before taxes or debt service.
§ Taxes paid by private water companies in Pennsylvania in 1944 equaled 13 per cent of revenue.

TABLE 9

*Assets of Pennsylvania Water Authorities, 1943–48**

Year Authorities Established	No. of New Authorities	Assets—$				
		1943	1945	1946	1947	1948
1939	3	16,645,207	17,298,746	17,518,347	20,622,609	22,619,634
1940	10	8,669,320	9,013,578	9,204,923	9,732,436	11,196,744
1941	12†	6,403,399	6,546,618	6,706,005	6,842,795	7,115,031
1942	8†	9,931,526	10,782,797	11,495,359	11,810,027	12,252,077
1943	6	9,913,188	10,169,925	10,348,478	10,729,396	10,934,924
1944	0		0	0	0	0
1945	3		3,046,928	1,060,539	1,859,668	4,322,940
1946	5			14,331,187	14,976,343	15,592,502
1947	7				8,730,678	9,036,703
1948						8,717,957
Total	59†	51,562,640	55,870,801	71,824,738	85,306,496	101,288,529

* Excluding 1944, for which no appropriate data were available.
† For purposes of comparison, data on Ross Township Authority (created in 1941 and taken over by Westview in 1946) were excluded from 1941 but included in 1942, as Westview authority was established in that year.

of operating income to bonded debt increased from 7.8 to 8.1 per cent. Thus, the analysis indicates a 22 per cent increase in total authority assets without any decrease in the ratio of operating income to bonded debt. A better standard of comparison would be the ratio of annual operating revenue to annual debt service, but the necessary data were not available.

Table 8 compares financial data on municipal, private and authority water systems. In Tables 9–11, statistics on assets, bonded debt, revenue, expenditure and income of Pennsylvania water authorities are broken down by classi-

TABLE 10

Bonded Debt of Pennsylvania Water Authorities, 1944–48

Year Authorities Established	Bonded Debt—$				
	1944	1945	1946	1947	1948
1939	7,964,000	8,174,000	7,996,000	9,660,000	10,672,000
1940	7,190,000	7,106,500	7,093,500	7,289,500	7,864,500
1941	5,435,000	5,392,000	5,336,000	5,128,000	5,103,000
1942	9,131,000	9,450,500	10,190,000	9,655,500	9,668,664
1943	9,417,000	9,352,000	9,382,950	9,513,950	9,398,888
1944	0	0	0	0	0
1945		2,745,000	2,664,000	1,492,000	1,927,000
1946			11,008,000	10,888,000	10,747,000
1947				6,894,000	6,976,500
1948					1,177,000
Total	39,137,000	42,000,000	53,103,450	60,655,450	63,710,552

TABLE 11

*Operating Revenue, Expenses and Income of Pennsylvania Water Authorities, 1943–48**

Year Authorities Established	1943	1945	1946	1947	1948
	Operating Revenue—$				
1939	1,484,285	1,434,985	1,363,156	1,727,047	1,822,088
1940	758,611	802,863	844,268	915,603	992,060
1941	529,972	553,842	584,962	606,254	645,026
1942	1,029,911	1,092,714	1,131,858	1,227,286	1,267,111
1943	788,711	973,493	1,001,559	1,073,720	1,130,980
1944		0	0	0	0
1945		357,825	233,190	286,501	311,785
1946			1,036,896	1,652,212	1,859,236
1947				361,471	615,288
1948					796,011
Total	4,590,490	5,219,432	6,192,103	7,850,099	9,439,585
	Operating Expenses†—$				
1939	684,793	410,618	433,151	504,073	564,358
1940	357,663	307,113	329,224	347,781	396,844
1941	356,887	229,600	249,894	263,598	294,779
1942	585,082	472,063	493,698	545,010	600,551
1943	570,806	438,870	438,784	546,854	560,564
1944		0	0	0	0
1945		87,963	101,452	107,848	124,768
1946			494,611	828,157	916,983
1947				133,101	180,220
1948					613,956
Total	2,555,231	1,945,288	2,540,904	3,276,324	4,253,023
	Operating Income—$				
1939	799,492	1,024,624	930,005	1,222,973	1,257,730
1940	400,949	496,031	515,044	567,821	595,216
1941	172,085	325,261	335,017	341,656	350,247
1942	445,329	620,651	638,160	682,178	666,560
1943	217,905	534,623	562,685	526,868	570,416
1944		0	0	0	0
1945		272,862	131,738	178,652	187,017
1946			542,285	824,055	964,109
1947				228,572	435,059
1948					182,055
Total	2,035,760	3,273,453	3,654,985	4,572,775	5,186,562

* Excluding 1944, for which no appropriate data were available.
† Includes operation, maintenance and depreciation, but not debt service.

fying the authorities in accordance with the year in which they were established.

It is interesting to note (Table 8) that the expenses per capita in 1945 were less for authorities than for the other types in Pennsylvania and in the United States as a whole. Moreover, the revenues collected per capita by authorities, and also the proportion of revenues to assets, are not out of line with those of the other types. It appears that the good financial position of the authority is not due to overburdening the customer, but is the result of exemption from taxes, fund diversions, free water services and dividends.

Summary and Conclusions

1. The data which have been presented indicate that authorities are prospering, while, at the same time, they are making improvements in facilities and in service rendered. They enjoy a cost advantage due to freedom from taxation. The payments they receive for public services are appreciable. This statement should not lead to the impression, however, that rates can be reduced.

2. There are many authority systems where an increase in rates could well be justified. This necessity is brought about by several factors which are almost universal, such as: [1] the lack of sufficient maintenance and depreciation allowances in past years; [2] the fact that the water service rendered is not up to modern standards; [3] the need for expansion, in some areas, to keep pace with demand and to attract industry; and [4] the great rise in operating costs and expenses.

3. Since, in nearly all water authorities, the entire system must be bought and paid for out of revenues within 40 years, operating revenues must be high in comparison with municipally owned systems, where a large percentage of the value of a water utility is debt free and depreciation reserves are generally neglected. If water authorities can amortize the debt in 40 years without an appreciable increase in rates, it is because of: [1] freedom from taxation; [2] freedom from fund diversion; [3] exemption from the necessity of supplying free water service; and [4] business management.

4. If major extensions and additions or new supply sources are required, the financing of new construction must be supported by a rise in the water rates.

5. Since the entire plant, works or properties of an authority may revert to the municipality at the end of 50 years, free of debt, the people of a community are buying a water works system when they pay their water bills. If the system is maintained, replacements are properly handled and the debt service is amortized, the community will receive a debt-free system.

6. The average per capita revenues of authorities are not being materially increased, with rare exceptions, and economical operation is generally being practiced. In effect, however, through the cancellation of taxes or the elimination of fund diversions and free water services, higher levies are actually being placed on the people of the community, because the equivalent cost of these services must be raised by taxation.

Reference

1. Hoffert, J. R. Public Authorities in Pennsylvania. Jour. A.W.W.A., **42**:127 (Feb. 1950).

Illinois Health Department Approval of Construction Plans and Specifications

By H. A. Spafford

A paper presented on April 14, 1950, at the Illinois Section Meeting, Chicago, by H. A. Spafford, Prin. San. Engr., Div. of San. Eng., State Dept. of Public Health, Springfield, Ill.

IN December 1949 the Illinois Dept. of Public Health formally adopted, under authority of the Illinois Civil Administrative Code, rules and regulations pertaining to the preparation and submission of plans and specifications for proposed installations, changes or additions to public water supplies. Copies of these rules and regulations were submitted to all municipalities having public water supplies, to privately owned public water utilities, to all water works superintendents, to consulting engineers practicing in Illinois and to equipment companies or their representatives.

The health department is concerned with three general phases of public water supplies: safe sanitary quality; adequate quantity; and reasonably desirable mineral quality. The first phase needs no amplification. The second—adequacy of public supplies—is of indirect public health significance. If supplies are so inadequate that water service fails, persons may seek out private water sources, which usually are subject to contamination. Moreover, low pressures can result in water contamination through back siphonage. The mineral quality of public supplies is also of indirect public health significance. A high iron, hardness and total mineral content may cause consumers to forego an assuredly safe public supply for other sources, usually private wells or cisterns, which are almost always subject to contamination when located in built-up areas.

Experience in the Sanitary Engineering Div. of the Illinois Dept. of Public Health has indicated that it is much easier to reach agreement with municipalities, water superintendents and designing engineers on details of sanitary quality, adequacy and mineral quality during the planning stage than to eliminate defects after construction has been completed. Certainly, it is more economical to build correctly in accordance with good public health standards and water works practice than to make the needed alterations later.

Sometimes construction to meet good public health standards may be more expensive. If increased expenditures will assure adequate and safe public water supplies, they are generally justified, within practical limits. Proper location or construction, however, often costs no more and sometimes may actually cost less. A good example is provided by the modern drilled well equipped with an above-base discharge turbine pump where the casing top extends a suitable distance above grade and can be effectively

sealed by the pump base. In the older installations employing well pits, not only was the pit itself often a costly structure, but provision for drainage was often either inadequate or dangerous and a costly well seal sometimes had to be used to close the annular space between the well casing top and the pump column. Nevertheless, some municipal officials and water superintendents, and even some consulting engineers, still plan well pit construction.

Questions of interpretation have arisen regarding two or three of the items in the rules and regulations as adopted. It will be noted that the regulations require plans and specifications for water main extensions to be submitted and approved. This rule seems justified in order to assure that proper methods of handling and installing pipe will be employed and, particularly, that proper main disinfection will be accomplished following construction. A few years ago one Illinois community experienced seven cases of typhoid fever because a water main and a sanitary sewer were permitted to lie open in the same trench and no attempt was made to disinfect the main before placing it in service. The need for some control of pipe materials, water main sizes and methods of installation has been especially emphasized in recent years by the large number of subdivisions and housing developments.

The regulations stipulate that water works plans are to be prepared by qualified persons, in accordance with the Illinois Professional Engineering Act of 1945, which provides for the registration of those practicing professional engineering, including the planning or design of the physical parts of water works structures. Therefore, water works plans and specifications should bear the official registration seal of the person responsible for the plan and design.

The health department rules and regulations on the submission of public water supply plans and specifications do not really inaugurate a new policy. They simply provide in writing certain principles, which the department has advocated for many years, to assure good public water supply improvements and attempt to stimulate universal use of good engineering and water works practice. The many water systems which now employ proper planning and design should experience little difficulty or inconvenience in complying with the rules and regulations. Where planning and design is not adequate at present, it seems obvious, in the interests of public health and ultimate community economy, that procedures to assure good water works engineering should be adopted.

APPENDIX

Rules and Regulations for the Submission of Plans and Specifications for Installations, Changes and Additions to Public Water Supplies

These rules and regulations were adopted December 1, 1949, by the Illinois Department of Public Health in accordance with Section 22 of an Act entitled "An Act to create and establish a board of health in the State of Illinois," approved May 28, 1877, and in accordance with Section 55 of an Act entitled "An Act in relation to the civil administration of State government and to repeal certain acts therein named," approved March 7, 1917, as amended. An amendment passed by the Sixty-sixth General Assembly and approved August 1, 1949, provides: "The Department of Public Health shall have power: . . . to require the submission of plans and specifications for public water supply installations, changes and additions excepting distribution piping beyond the consumer's service or building service connection, and to prepare and enforce rules and regulations relative to the preparation, submission and Department approval of such plans and specifications. . . ."

Penalties for violation of State Department of Public Health rules and regulations are provided in Section 24 of an Act entitled "An Act to create and establish a board of health in the State of Illinois," approved May 28, 1877, as amended, which states: "Any person who violates or refuses to obey any rule or regulation of said [State Department of Public Health] shall be liable to a fine not to exceed $200 for each offense or imprisonment in the county jail not exceeding six months, or both, in the discretion of the court. . . ."

1. Definitions

"Public water supply" as used in these rules and regulations shall include all water works and appurtenant facilities for producing, conditioning or distributing water as a public service through a system of distribution piping for drinking and general domestic use.

2. Submission of Public Water Supply Plans and Specifications Required

Plans and specifications shall be prepared for all public water supply installations, changes or additions as hereinafter stipulated, which plans and specifications shall be submitted to the Department of Public Health for review and issuance of written Department approval, before construction work is begun. Plans and specifications shall be submitted a reasonable period of time in advance of start of construction to permit proper review, the making of any required changes in plans and specifications, and the issuance of written approval of the approved plans and specifications.

3. Scope of Requirement

Plans and specifications shall be prepared and submitted and approval shall be obtained from the Department before construction is started for the following public water supply projects: new wells, deepening or recasing of existing wells; new pumps and pumping stations, including pump suction lines; new water storage structures and major changes to existing storage facilities; new work or changes for impounding reservoirs, dams, spillways and intakes; new or expanded water treatment facilities; any new work and all changes in location or construction of sewers, drains or manholes and other sewerage facilities carrying storm

water, sanitary sewage or any other liquid waste, when such sewerage facilities exist or are to be located 100 ft. or less from public water supply structures which are or may become vulnerable to the entrance of contamination, such as wells, water storage reservoirs, pump suction lines and other low-pressure water pipes and conduits; all water lines and distribution system extensions, except as hereinafter exempted; any other construction for, or alteration to, public water supplies, appurtenances and related facilities, where such construction or alteration may affect the sanitary quality, adequacy or mineral quality of public water supplies.

It shall not be a requirement to submit plans and specifications and obtain approval for routine repair and maintenance work on public water supplies, including repair of water main leaks, repair of valves, painting of elevated tanks and other, similar maintenance. The tapping of existing water mains, the installing of additional service connections and the installation or alteration of water consumer's private distribution piping shall likewise be exempted.

4. Qualified Persons to Prepare Plans and Specifications

All plans and specifications required to be submitted and approved under these rules and regulations shall be prepared by persons properly qualified to perform public water supply or water works planning and design as provided in the Illinois Professional Engineering Act, approved July 20, 1945.

All public water supply plans and specifications submitted to the Department shall bear the official registration seal of a person qualified and responsible for their preparation.

5. Completeness of Plans and Specifications

Plans and specifications shall be sufficiently complete to describe clearly the work to be performed and shall include all essential details which concern the sanitary quality, the mineral quality and adequacy of the public water supply. Plans and specifications shall be accompanied by engineering reports and surveys, design data and any additional information pertinent to the proposed work which may be required by the Department.

6. Legibility of Plans and Specifications

Plans and specifications shall be clearly legible. Specifications shall be typed, printed or mimeographed. Plans shall be prints or photostatic copies made from master tracings or drawings.

7. Copies Required and Ownership of Submitted Plans and Specifications

One complete set of both plans and specifications shall be submitted to the Department for review. One copy of any revisions of plans and specifications shall likewise be submitted. One complete set of all plans and specifications submitted shall become the property of the Department. After plans and specifications have been approved, one or more additional complete sets, as approved, shall be submitted, if requested by the Department, which sets shall also become the property of the Department.

8. Review and Approval of Public Water Supply Plans and Specifications

Plans and specifications for public water supply projects submitted to the

Department will be reviewed within a reasonable time after being received. Those plans and specifications which are found to be satisfactory will be approved in writing, the approval being issued with a reasonable number of copies for the convenience of the public water supply owner.

When review of plans and specifications by the Department shows them to be unsatisfactory for approval, a letter of review will be issued, presenting the Department's objections. Upon receipt of satisfactory revisions of plans and specifications, approval will then be issued.

Department approval of public water supply plans and specifications shall become void one year after date of issue, unless construction on the project shall have begun before the expiration date.

Validity of approvals shall be dependent upon compliance with all conditions which may be included in the written approval. Noncompliance with any such included conditions shall subject the approval to revocation.

9. Changes in Approved Plans and Specifications

There shall be no deviations in public water supply construction from the approved plans and specifications unless revised plans and specifications shall first have been submitted to the Department and written supplemental approval issued therefor.

10. Department to Be Notified When Public Water Supply Construction Is Completed

The Department of Public Health shall be notified when the public water supply installations, changes or additions, provided for by the approved plans and specifications, are to be placed in service.

Erratum

In the panel discussion "Effects of Synthetic-Detergent Pollution," published in the January 1950 JOURNAL (Vol. 42, p. 17), the section headed "Appleton Experience," by William U. Gallaher, contains an error. On p. 23, column two, line 28, the word "sulfate" should have read "sulfite." The corrected sentence reads:

> It is the opinion of colloid chemists that 1 ppm. of tannates or sulfite wastes from pulp mills will adversely affect the coagulation of water.

Valve and Hydrant Maintenance

By Howard W. Niemeyer

A paper presented on April 28, 1950, at the Indiana Section Meeting, Lafayette, Ind., by Howard W. Niemeyer, Supt. of Distr., Indianapolis Water Co., Indianapolis, Ind.

CONSUMER dependence on an uninterrupted public water supply has grown almost beyond belief within the past two decades or so. Mechanical refrigeration, air conditioning, water-cooled industrial machines and other modern uses are creating such a continuity of essential demands that there is no longer a satisfactory or convenient time to shut off water service. Simultaneously, public tolerance for interruptions even in normal domestic service seems to be disappearing. This demand for a higher standard of service will force the plant operator to give more and more consideration to valves and hydrants.

Systems with inadequate valving will require the installation of additional main-line valves to minimize the areas of service interruptions which cannot be avoided. Unvalved hydrant leads, particularly in critical areas, will need valving to eliminate main shutouts during repairs. More thought will have to be given to the selection of the type of valves to be installed in large feeder mains for operation against unbalanced pressure. Particular attention must be paid to the design and structure of valves, to insure their endurance for the life of the pipeline so that they themselves will not be a cause for service interruptions to effect their repair or replacement. A preventive maintenance program for valves and hydrants, which has always been good operating practice, has become a must in perpetuating their readiness to serve.

It is unfortunate that valves and hydrants are not self-sustaining. The infrequency of their use may lead to the false assumption that they are not subject to wear and therefore remain in good operating condition without attention. The converse is more likely to be true, however, in that lack of use may be more detrimental than frequent operation. There are numerous forces at work which can cripple or destroy their usefulness for the purpose for which they were installed.

Corrosion

Probably the most serious distribution system problem today is corrosion. One phase of this problem has resulted from the promiscuous use of unprotected dissimilar metals in the structure of system components. Cast iron and bronze have long been the common metals used for water works materials. Separately they have an excellent record of endurance, but, suspended together in a solution, they produce galvanic corrosion. The rate and effect of this corrosive action in valves and hydrants will depend on their design and on the mineral content of the water, but it is always detrimental.

Until such time as this problem is fully recognized and solved in either metal or structure design, the plant operator's difficulties will continue. It may be noted that galvanizing of the iron parts has been tried with some degree of success, but experience with this type of protection is insufficient to determine its long-range effectiveness.

In any corrosive action, there is a loss of metal, which results in a weakening of the affected part. If it is a working part subject to operating strain, progressive corrosion can eventually lead to failure. Equally as serious in valves are the products of corrosion, which form on the surfaces of moving parts and reduce or eliminate entirely the essential clearances needed for their freedom of movement. Periodic operation of valves will break off the corrosion deposit and help maintain the required clearances. Valves that have not been used for many years may be found to be entirely inoperative, because corrosion has swelled and then welded the moving parts into an unmovable, oversize mass.

Corrosion in hydrants does not exist in the same degree as in valves since the moving parts normally remain relatively dry. This situation changes, however, if the hydrants are set in an area of ground water that is sufficiently high to submerge their lower operating parts. Then corrosion can make their condition deteriorate enough to cause failure.

The stuffing-box gland of valves and hydrants is another source of difficulties presenting maintenance requirements. Corrosion that is primarily galvanic also takes place at this point and fills the clearance space about the stem with deposits. The most serious effect of this action is the increase in torque required to operate the affected valve and hydrant. Periodic operation will tend to work the deposit out of the gland and keep the operating stem moving freely, while neglect will allow the deposit to grow and harden until the stem becomes tightly wedged in the gland.

Of course, periodic operation of the valves and hydrants will cause a disturbance in the packing material in the stuffing gland. If this material has lost its resiliency, the gland will start leaking. This condition is not a problem in hydrants since they can readily be repacked, and it does not become a problem in valves until they leak continuously with the stem collar seated against its socket. A valve that leaks only during its operating cycle is a fault which is not serious enough to warrant the expense of the pavement cutting necessary to install new packing. Packing failures are sufficiently common, however, to require careful selection of the material to be used. The most satisfactory packing will be one that is noncorrosive, has permanent lubricating qualities, will not dry out and will seal with a minimum clamping pressure. Experience indicates that only a few types of packing will meet all of these requirements.

Street Improvement

High on the list of causes of valve and hydrant difficulties is street improvement and maintenance work. Experience would indicate that street contractors and city maintenance crews do not share the plant operator's view of the importance of keeping the utility's appurtenances in readiness for emergencies. Apparently they consider valve boxes and vaults as objects to be destroyed or buried, and fire hydrants

are merely bumping blocks for bulldozers and road graders. Rigid inspection of all known street improvement jobs is necessary to see that all valve boxes and vaults are in position and properly graded. It is helpful to make a survey in advance of the construction work and to drive reference stakes along property lines to mark the location of all valves. It is also good practice to install new packing in the valves and to perform any other needed maintenance before a new pavement surface is put in place. If additional valving is advisable in the area of the street improvement, it can be installed without paying the high cost of pavement cutting and repairing. In addition, hydrants may have to be relocated to suit changes in curbings.

Street improvement or major resurfacing projects can be watched to guard against damage to the distribution system parts, as the utility will have advance notice of such work. It is the street maintenance crews, who cannot be followed, that are responsible for the large number of valve boxes covered or destroyed each year. Asphalt patching crews can be depended upon to cover with bituminous material any valve box in the area of a street repair. Road graders used on the unimproved streets will regularly break or tear up valve boxes without such damage being reported to the utility. The time lost by the utility in emergencies because of these artificially created difficulties can be quite serious.

Homeowners, in regrading their lawns, may either extend a terrace or cut the grade around a hydrant located at the property line. In the former situation, the hydrant nozzles may be so close to the ground as to interfere with the connection of a fire hose. In the latter, the hydrant is left standing high in the air, an unsightly object, and frost may penetrate to the base because of insufficient earth cover. Owners also have built fencing so close to a hydrant that it prevents the spinning of the operating wrench. These home projects which create hydrant hazards are seldom reported.

Effects of Traffic

Traffic can result in unfavorable conditions. Valve boxes located in an unstable road bed may be shifted by traffic loads so that the operating key cannot be engaged with the valve key nut. Boxes may be tilted so that a protruding edge becomes a hazard to pedestrian traffic. Vaults may become weakened, leading to the danger of a cave-in under traffic.

Hydrants are also traffic casualties and can be damaged in unreported collisions so as to render them useless to the fire department. They may be knocked out of alignment, the nozzle threads injured, the nozzles knocked loose in their sockets, or the base assembly damaged by an impact. In one hydrant, a test showed the barrel to have been broken in two, yet the hydrant appeared to be in good condition. If such damage is not reported to the utility, it must be found by regular inspection, or the faults may continue to exist until a hydrant is needed for fire fighting.

In replacing collision-broken hydrants, it is well to inspect their setting to determine if they need be relocated to a less vulnerable position. Hydrants should be set a safe distance from a curb and as far from street intersections as possible. The breakoff type of hydrant has many advantages and merits careful consideration. A colli-

sion with this type does not result in an emergency, and, since the broken section is readily discernible, a prompt report will probably be made to the utility. Furthermore, repairs can be made without shutting off the main.

Freezing Climates

In freezing climates, where hydrants must drain for wintertime service, tree roots are always a source of difficulty. The importance of keeping the drain ports open is obvious. It is a good practice during the winter to check all hydrants as soon as possible after their use by the fire department. Nondraining hydrants should immediately be drained with a handpump to keep them in readiness for additional service until a maintenance crew can open the drain ports. Clogged drains can often be opened with compressed air to avoid an excavation job. The installation of a piece of copper wire or tubing in the hydrant drainage bed to stop root growth has been suggested.

Much damage can result to valves and hydrants through their use by inexperienced or unauthorized persons. Valves may be left partially or completely closed. Hydrants may be damaged or left partly open. Hydrant caps may be left loose or not replaced at all. To safeguard against these irregularities, all valve and hydrant operations should be strictly confined to the distribution system maintenance division, and operation by any other plant personnel or by outsiders such as street contractors, construction workers or contractor main-laying personnel should be prohibited. Temporary hydrant connections occasionally required by outsiders should be furnished by the utility with the installation of a hand wheel valve on a hydrant nozzle, leaving the hydrant open for the duration of the use. Such hydrant operation should be reported to the fire department. This policy assures that full knowledge of all valve changes will be available to the division responsible for distribution system emergencies, and it limits all operations to experienced personnel.

An exception to the above policy will, of course, have to be made for the fire department and city street-flushing and sewer-cleaning crews. There should be a special effort to give these groups instruction in the proper use of hydrants. A sectional hydrant can be furnished by the utility for training purposes.

All instructions should particularly emphasize the importance of replacing all nozzle caps as tightly as possible. Failure to do so is an invitation to trouble from the younger generation.

Testing Programs

Ample illustrations have been given to prove the need for periodic inspection of valves and hydrants if they are to be maintained in a ready-to-serve condition. Should the many faults that can and do develop be left to accumulate over a period of years, the plant operator might find himself in a desperate situation when a real emergency arose. The frequency of periodic inspections varies, but generally a yearly interval is adopted. The hydrant testing program is preferably conducted during the fall since most faults develop in the spring and summer. Autumn testing also allows conditioning of the hydrants ahead of winter service requirements. There is no particular seasonal advantage for valve testing.

Complete and accurate maps and records of the distribution system are essential in establishing the testing programs. Simply stated, a valve cannot be tested if there is no record of its installation. Numerous water works publications have described map and record systems that are considered good practice. It is suggested that, in addition to the standard system records, it is worth while to have a permanent test report card for each valve and hydrant. Such a card carries a complete description of all physical data regarding each installation—make, size, type, location, measurements from reference points, date of installation, identification number and a test route number. In addition, the valve test card should show the type of setting (box or vault), the number of closing turns and the direction of turning, if any plant operator is so unfortunate as to have mixed directional valves in his system. A 5 × 8-in. card will allow enough horizontal lines for at least 30 test reports, using both sides. Vertical columns with headings of items to be reported will permit the testing personnel to use check marks, requiring only a minimum of writing. The cards should be filed in the office by route number and should be taken out in the field only in quantities sufficient for a day's work.

The use of test report cards has a number of advantages: Once an efficient testing route has been developed, it can be followed for all subsequent tests. There is less likelihood that any valves or hydrants will be missed. The testers carry with them, in convenient reference form, complete information regarding each installation, and also have the benefit of all past testing history, so that they are aware of any abnormal condition that may exist. A considerable saving in paper work results.

As previously mentioned, the existence of both left- and right-hand valves in a system is an unfortunate circumstance, particularly if there is an absence of maps and records which accurately specify the operating direction of each valve. It would appear that valve operations are confusing enough to warrant the conversion of all valves to a single operating direction.

The testing of valves and hydrants requires the operation of the devices through their entire cycle, as partial operation is insufficient to establish their true condition. The purpose of the inspection is to determine readiness to serve, which can be judged only from a complete test.

Minor Maintenance

During the test deficiencies other than faulty operation should be detected almost automatically, and certain items of minor maintenance should be performed as part of the testing program.

The hydrant work should include lubrication of the operating nut, tightening or replacement of the stuffing-gland packing as needed, greasing of the nozzle cap threads and calking of loose nozzles. Obstructions to the visibility of the hydrant and poor condition of paint should be noted in the test report. It is also suggested that, since travel time is a considerable item in the inspection cost, other types of surveys can be incorporated in the program at slight added expense. Little time is required for the testing crew to listen in on each hydrant with some type of mechanical or electronic leak detector. A pressure survey of the entire distri-

bution system can be readily obtained by having the crew install a nozzle cap equipped with a pressure gage. Some utilities take a pitot measurement of each hydrant's delivery rate, while others have the testing crew flush all hydrant leads and some dead-end mains. Three men can test about 120 hydrants in an eight-hour day. The addition of a leak and pressure survey to the program will only reduce the number of hydrants tested in the same length of time to 100.

The maintenance work which can be incorporated in a valve testing program is rather limited because the valves are inaccessible unless installed in vaults. Stuffing-box packing can be replaced or tightened in vaulted valves, if required. Likewise, geared valves can be cleaned and lubricated as needed. Maintenance of buried valves during testing is limited to finding and adjusting the height of valve boxes in dirt streets and cleaning boxes of obstructions. Hard-turning valves and those which will close only partially should be worked until they operate freely. It has been found helpful in working a hydrant branch valve to open the hydrant sufficiently to secure a scouring velocity through the valve. Sometimes a scouring velocity can be obtained through main-line valves by closing off a section of main in back of the valve and opening a hydrant leading off this section. Even valves with kinks in the stem which allowed only partial closure have been worked until the valve operated freely through the kinked section. The operaton of these faulty valves is considered an important part of the testing program. Each valve which can be conditioned in this manner eliminates a main shutoff, a street excavation and the need for opening the valve in order to make repairs.

Power Operation

In the author's opinion an adequate and satisfactory job of valve testing cannot be done manually. Even if all the valves were in perfect condition, the physical requirements for testing a system of any size would place a considerable strain on the personnel. It is not possible to operate faulty valves manually in the way previously discussed. Power operating equipment is available for such work and should have preference.

One method of power operation is the use of a compressor-driven air motor of low speed. This type has the advantage of reaching valves inaccessible to trucks, but there is a drawback in that the air motor must be held by the crew in opposition to the turning torque of the valve. As in manual testing, the valve turns must be counted and there is always a likelihood of error, particularly in operating large valves which require a great many turns.

Another method employs a truck-mounted operating head powered by a takeoff from the truck engine. The head can be mounted on the right-hand side so that valves near a street curb can be reached by the operator with the truck going in the direction of traffic. With the right-hand mounting, the revolution counter, which is part of the equipment, is installed on the truck instrument panel, enabling the testing personnel to synchronize the flow of power with the registered position of the valve faces. Damage to valves is avoided by the use of multiple shear pins in the driving linkage, varied in number to suit the size of valve being

tested. This type of power testing has made a hard job easy and has been used with most satisfactory results for all sizes of valves, even down to 4 in. Excellent results have been obtained with it in conditioning valves.

The valve testing truck at Indianapolis, Ind., is equipped with a phone, and the testing crew has been given the assignment of making emergency and routine main shutouts. Tighter valve closures are being obtained than with manual operation, and the maintenance crews have drier repair jobs.

There are intangible benefits to be derived from the periodic testing of valves in addition to those resulting from the location and repair of faults. The valve operating crews become thoroughly acquainted with the distribution system, its shutoff sections, the location of valves and their operating characteristics. With this experience, they can meet an emergency situation with precision, and valuable time is saved when it is needed most.

Valve and hydrant defects reported by the testing crew should be repaired as quickly as possible, the inoperative ones being given initial preference.

Hydrant painting is not connected with the testing program but is a maintenance job that should also be performed on an established schedule. The selection of the color to be used should be based entirely on visibility, particularly at night. The frequency of painting will be determined by the durability of the paint and the exposure of the hydrant to grime and dirt. Some utilities paint the hydrant bonnets and caps according to a color code which denotes the delivery capacity of each hydrant. This practice is an aid to the fire department.

The National Board of Fire Underwriters has established minimum standards for the installation of valves and hydrants needed to maintain adequate fire protection service. In order to satisfy these recommended standards and at the same time meet the high level of general service required by modern public water supply uses, valves and hydrants must be given proper consideration.

Experience With High-Rate Filtration

By John R. Baylis

A paper presented on May 23, 1950, at the Annual Conference, Philadelphia, by John R. Baylis, Engr. of Water Purif., South Dist. Filtration Plant, Chicago.

HIGH-RATE filtration is the operation of filters at rates in excess of 2 gpm. per square foot. An account of Chicago's experience with high-rate filtration was included in a paper published in 1949 (1). Several filters were being run at 2–2.5 times their normal rating. These filters have now been in service over two years. The present paper will bring the data up to date and discuss the economics of high-rate filtration.

On February 1, 1948, two filters in each of the four filter galleries at the Chicago South Dist. Filtration Plant were set to operate at rates of 4 gpm. per square foot, following a period during which several filters in Gallery 1 were operated at rates above 3 gpm. After nine months of operation at 4 gpm., the rate of one high-rate filter in each gallery was increased to 4.5 gpm. The 4-gpm. filters are No. 1, 21, 41 and 61; the 4.5-gpm. filters are No. 11, 31, 51 and 71; two filters, No. 10 in Gallery 1 and No. 80 in Gallery 4, were set to operate at a rate of 5 gpm. These ten are distributed throughout the 80 units of the plant so as to be representative of all of the filters. Four units are operated at 3-gpm. rates in the summer and at 2-gpm. rates in the winter. The other filters are operated at variable rates, being controlled automatically to vary the total filtration rate of the plant in accordance with the needs of the south water district.

Hydraulic conditions in the South Dist. Plant are none too good for very high rates of filtration. At the 5-gpm. rate, there is a head loss of about 4 ft. in the filter effluent piping and the rate controller. With the filtered-water reservoirs full, the maximum increase in loss of head over the initial loss is only 3–4 ft. Consequently, the filters must be washed more often than would be necessary if the loss of head could increase 6–7 ft. over the initial, as it can with lower rates of filtration. Part of the high initial loss of head may be corrected by design. Lowering the water level in the filtered-water reservoirs would allow the filters to increase to a higher head loss.

Figure 1 shows the effect of filtration rate and temperature on the initial head loss of filters. With filtration rates of 5 gpm. and less, the initial loss of head is almost a straight-line relation. The loss of 1.80 ft. through the sand bed at the 5-gpm. rate at 32°F. may seem high. The highest rates in a filtration plant generally will occur in the spring, summer and fall, when the temperature of Lake Michigan water is above 45°F.

Since more filter washes per day are required for the high-rate filters, the per cent of the time they are in service is important. Tables 1 and 2, which

TABLE 1—*Time in Service*

Month	Time in Service—*per cent*							
	4.0-gpm. Rate							
	Filter No.							
	1	11	21	31	41	51	61	71
1948								
March	97.0	97.0	97.2	97.2	94.3	93.8	97.7	97.5
April	97.6	97.6	97.7	98.2	97.0	98.2	98.2	98.2
May	96.0	96.2	96.1	96.4	95.0	95.8	96.4	97.3
June	96.3	96.7	97.8	97.3	97.0	97.1	97.0	97.1
July	96.4	96.5	97.3	97.2	97.3	97.4	97.3	97.0
Aug.	98.6	98.6	98.6	98.6	98.3	97.8	97.7	97.8
Sept.	98.4	98.4	98.7	98.4	97.8	97.6	98.4	98.4
Oct.	98.2	97.4	97.0	97.1	97.2	97.1	98.4	97.1
Avg.	97.3	97.3	97.5	97.5	96.7	96.8	97.6	97.5
General Avg.	97.3							

Month	4.0-gpm. Rate				4.5-gpm. Rate				5.0-gpm. Rate	
	Filter No.									
	1	21	41	61	11	31	51	71	10	80
1948										
Nov.	96.5	96.2	96.1	96.2	95.5	96.0	95.8	95.8		
Dec.		96.2	95.7	95.5		95.8	95.0	94.9	93.2	93.2
1949										
Jan.	98.0	98.0	97.4	97.6	97.2	95.8	97.4	97.2	95.7	95.4
Feb.	98.0		97.6	98.3	97.4		97.6	97.1	96.3	96.3
March	98.3	97.6	97.9	98.2	97.8	97.5	97.6	97.8	97.2	97.3
April	97.7	97.1	97.4	96.8	97.4	97.0	97.0	96.5	96.0	95.7
May	97.8	97.5	97.5	97.0	97.2	97.1	96.8	96.5	96.7	96.0
June	97.6	97.3	97.1	96.7	97.1	96.4	96.4	96.3	96.5	95.7
July	98.6	98.0	98.2	97.8	97.9	97.7	97.8	97.4	97.3	97.0
Aug.	98.8	98.5	98.5	98.5	98.4	98.3	98.3	98.2	98.0	97.8
Sept.	98.7	98.5	98.4	98.3	98.4	98.3	98.0	97.8	97.8	97.7
Oct.	97.3	96.9	97.2	97.5	96.5	96.7	96.6	97.0	95.5	96.2
Nov.	97.6	97.4	97.4	97.5	96.8	97.4	96.9	96.7	95.8	96.5
Dec.	97.6	96.8	96.7	96.7	96.8	96.6	96.1	96.1	96.0	95.7
1950										
Jan.	97.0	96.7	96.7	96.8	95.8	96.6	96.2	96.2	95.0	95.7
Feb.	97.2	96.8	96.7	96.7	96.3	96.7	96.2	95.9	95.5	95.5
Avg.	97.8	97.3	97.3	97.3	97.1	96.9	96.9	96.7	96.2	96.1
General Avg.	97.43				96.90				96.15	

give summaries of the time in service for the high-rate filters, show that the time out of service for washing is not a large proportion of the total. A 4-gpm. filter can be drained to wash about twice as rapidly as a 2-gpm. unit. Since the actual washing and filling time is the same regardless of rate, the percentage of time out of service for washing is greater for the high-rate filters because of the increased number of washes. If filters operated at the 2-gpm. rate are out of service for washing 2 per cent of the time and 4-gpm. filters are out of service for washing 5 per cent of the time, a 4-gpm. rate requires about 0.53 times as much filter surface area as a 2-gpm. rate, instead of one-half the area.

The turbidity of the filtered water from the 5-gpm. filters is given in Table 3. Very few tests show a filtered-water turbidity above zero. When a slight turbidity was present it was usually caused by colloidal and not coagulated matter. Floc volume tests were also made on all of the samples, with only 0.1 per cent of the samples showing more than a trace of coagulated material in the filtered water (Table 4).

The colloidal turbidity in filtered water is dependent on the effectiveness of the coagulation treatment given the water. If it is not properly coagulated, colloidal turbidity will pass through all of the filters regardless of the rate of filtration. In most filtration plants, the aim is to produce water with colloidal turbidity of not more than 0.2. At Chicago, the goal is to average not more than 0.1, with no sample exceeding a turbidity of 0.5. The filtered water has averaged less than 0.1 turbidity.

The floc volume (made up of coagulated material) should average less than 1.0, although no definite figure has been set as an objective. The test is made and recorded as volume of floc. One gallon of compact floc in 1 mil.gal. of water equals a floc volume of 1.0. The floc volume averages about fifteen times the turbidity; that is, a floc volume of 1.0 indicates about 0.07 turbidity. As shown in Table 4, the 5-gpm. filters produce results well within the quality desired for floc volume. Only a few samples have yielded a floc volume above a trace. Because of the labor involved, tests were not made on the other eight high-rate filters.

Table 5 summarizes the results of bacteriological tests on the ten high-rate filters and eight low-rate filters. The tests were started in August 1949. Although the water is prechlorinated all of the time, postchlorination is often required. During the periods of high pollution, the residual chlorine in the water applied to the filters was frequently maintained at a low level purposely, to avoid interference with the activated carbon added for taste and odor removal. The appearance of coliform bacteria in some of the samples, therefore, is of no significance, for the postchlorination gives additional sterilization.

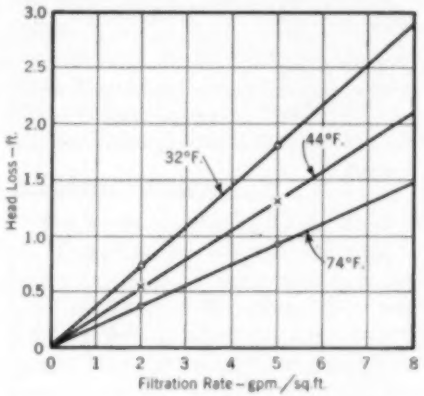

FIG. 1. Temperature, Filtration Rate and Initial Head Loss

TABLE 2—*Length of Filter Run*

Month	Length of Run—*hr.*							
	4.0-gpm. Rate							
	Filter No.							
	1	11	21	31	41	51	61	71
1948								
March	15.1	15.1	12.1	12.7	22.9	19.1	18.2	16.2
April	18.5	17.6	16.4	16.8	18.1	16.0	17.6	18.6
May	12.5	10.8	11.7	11.7	14.9	10.5	12.7	13.7
June	14.3	11.4	14.1	13.8	14.7	12.5	13.0	12.3
July	14.5	13.5	13.5	14.8	15.5	14.3	13.7	12.5
Aug.	21.5	21.6	20.9	20.4	21.5	20.8	19.3	19.2
Sept.	21.5	19.7	20.9	20.9	22.2	20.9	21.8	20.3
Oct.	15.6	14.7	12.7	12.7	13.0	12.9	11.6	11.0
Avg.	16.7	15.6	15.3	15.5	17.8	15.9	16.0	15.5
General Avg.	16.0							

Month	4.0-gpm. Rate				4.5-gpm. Rate				5.0-gpm. Rate	
	Filter No.									
	1	21	41	61	11	31	51	71	10	80
1948										
Nov.	10.6	10.1	8.8	9.1	7.9	9.2	8.0	8.0		
Dec.		8.9	8.8	8.5		8.3	7.8	7.4	6.8	5.7
1949										
Jan.	16.1	16.3	12.9	14.0	12.3	13.9	12.3	10.6	9.5	8.1
Feb.	19.6		14.7	13.3	13.9	12.7	12.3	10.5	10.0	8.8
March	21.5	14.3	14.8	17.9	16.5	13.4	12.4	13.8	12.5	11.2
April	13.0	10.0	11.7	15.0	9.2	9.6	10.0	12.7	7.7	9.5
May	15.5	12.1	12.7	10.9	11.7	10.3	10.6	9.2	9.2	7.7
June	14.6	11.3	10.6	9.4	10.9	8.7	8.4	7.8	8.7	6.8
July	22.2	16.6	16.6	15.7	15.5	13.9	14.0	12.5	12.9	10.9
Aug.	28.3	23.7	21.5	22.2	20.9	21.5	19.2	17.4	16.2	14.3
Sept.	24.5	20.8	22.1	21.5	18.6	18.6	19.1	16.8	14.7	15.0
Oct.	11.7	9.9	10.8	12.5	8.7	9.1	9.1	9.9	7.0	8.4
Nov.	12.8	11.3	12.5	12.8	9.2	10.9	10.3	10.1	7.1	9.0
Dec.	12.1	9.4	9.8	10.2	8.7	8.3	8.2	8.1	7.3	7.1
1950										
Jan.	9.4	8.8	9.3	10.0	6.8	8.3	8.2	8.0	5.5	7.0
Feb	9.3	7.9	9.0	9.4	7.0	7.6	7.9	7.5	5.6	6.7
Avg.	16.1	12.8	12.9	13.3	11.9	11.5	11.1	10.6	9.4	9.1
General Avg.	13.8				11.3				9.3	

The general average of the coliform bacteria counts for the high-rate filters (Table 5) happens to be slightly less than for the low-rate filters, because of two high counts found for the latter. The number of samples in which coliform bacteria were found was greater for the high-rate filters. The number of coliform bacteria averaged so low, as a result of prechlorination, that bacterial counts may be said to be without significance in evaluating high-rate filtration.

The continuous filtration of a small stream of water (about 100 ml. per minute) from each filter through cotton constitutes the most sensitive test on filtered water. A description of the cotton plug filter was given in the article previously cited (1). The cotton plugs are removed each week, dried and burned to ash in a crucible, the weight of the ash then being determined. Table 6, which gives the average cotton plug filter test findings for the period July–December 1949, indicates that more coagulated material passed through the high-rate than through the low-rate filters, a result to be expected. Since the amount was so small, however, that it could not be measured by other test methods, the depreciation in quality is of no practical significance. Activated carbon adds considerably to the ash content, particularly when applied to the filters directly. Had no activated carbon been used, the amounts of ash from the cotton plug filters would have been much less, probably not one-half those shown. When high dosages of activated carbon are needed, increased dosages of aluminum sulfate are also required to precipitate the carbon. In order to save on coagulation chemicals, the dosage usually is such as to allow some carbon to pass through the filters.

The filter performance is the amount of water filtered per foot increase in loss of head. Performance may be expressed in gallons of water filtered per square foot of filter surface for a 1-ft. increase in loss of head, or it may be expressed in million gallons filtered per filter for a 1-ft. increase. The filter performance figures in Table 7, given in million gallons per filter, are greater for the high-rate than for the low-rate filters.

Tests extending over a two-year period show that filters operated at rates of 5 gpm. per square foot or less produce an excellent quality of water. The 5-gpm. rate, therefore, may be used on all filters in the plant without fear of jeopardizing quality. The hydraulics of the South Dist. Filtration Plant permit a rate of 600 mgd.

Economic Factors

The development, in 1936, of means of strengthening coagulation used in water purification presented new possibilities in water filtration. For years water chemists and engineers had assumed that the strength of coagulation formed by the addition of aluminum sulfate or an iron compound to the water could not be greatly altered. Any change noted in the rate of filter clogging was believed due to natural causes, such as the growth of microorganisms or certain characteristics of the suspended matter in water. Sand with an effective size of 0.4–0.5 mm. was, and still is, used most extensively, with the present trend toward coarser sand. Filters are designed generally for a filtration rate of 2 gpm. per square foot, with a trend toward higher rates.

As few waters are alike, some filtration plants fall short of producing water of the highest quality all of the time. But the filters can often be

TABLE 3—*Turbidity—5-gpm. Filters*

Day	1949												1950	
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
	Filter 10													
1	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
2		0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0
3		0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0
4		0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0		0.0	
5		0.0	0.0	0.0	0.0		0.0	0.0		0.0		0.0	0.0	
6				0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
7			0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
8		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
9		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
10		0.0	0.0		0.0	0.0		0.0	0.0	0.0			0.0	0.0
11		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0			0.0	
12		0.1	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	
13				0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
14	0.0	trace	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
15	0.0	0.0		0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
16		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
17		trace	0.1		0.0	0.0		0.0		0.0	0.0		0.0	0.0
18	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	
19		0.0	0.0	0.0	0.0		0.0	0.0		0.0		0.0	0.0	
20	0.0			0.0	0.0	0.1	0.0	0.0		0.0		0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0		0.0
22	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		
23		0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
24		0.0	0.0		0.0	0.0		0.0		0.0			0.0	
25	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0		0.0	0.0		0.0	0.0
26	0.0	0.0	0.0	0.2	0.0		0.0	0.0	0.0	0.0			0.0	
27	0.0			0.1	0.5	0.1	0.0	0.0	0.0	0.0		0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
29	0.0			0.0		0.0	0.0	0.0	0.0		0.0	0.0		
30			0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	
31	0.0		0.0		0.0			0.0		0.0			0.0	
	Filter 80													
1		0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
2		0.0			0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0
3		0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0
4	0.0	0.0	0.0		0.0	0.0		0.0		0.0	0.0		0.0	
5	0.0	0.0	0.0		0.0		0.0	0.0		0.0		0.0	0.0	
6	0.0				0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
7	0.0		0.1		0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0		0.0
		0.0	trace		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
10		0.0	0.0		0.0	0.0		0.0	0.0	0.0			0.0	0.0
11	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0			0.0	
12	0.0	0.1	0.0		0.0		0.0	0.0	0.0	0.0		0.0	0.0	
13	0.0				0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
14	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
15	0.0	trace	0.1			0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
16		0.0	trace		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
17		0.0	0.1		0.0	0.0		0.0		0.0	0.0		0.0	0.0
18	0.0	trace	0.1		0.0	0.0	0.0	0.0		0.0	0.0		0.0	
19	0.0	0.0	0.0		0.0		0.0	0.0		0.0		0.0	0.0	
20	0.0				0.0	0.1	0.0	0.0		0.0		0.0	0.0	0.0
21	0.0	0.0			0.0	0.0	0.0			0.0	0.0	0.0		0.0
22	0.0	0.0			0.0	0.0	0.0	0.0		0.0	0.0	0.0		
23		0.0		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
24		0.0			0.0	0.0		0.0		0.0			0.0	0.0
25	0.0	0.1		0.0	1.5	0.0	0.0	0.0		0.0	0.0		0.0	
26	0.0	0.0		0.1	0.0		0.0	0.0	0.0	0.0			0.0	
27	0.0			0.1	0.0	0.1	0.0	0.0	0.0	0.0		0.0	0.0	0.0
28	0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
29	0.0			0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	
30				0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	
31	0.0				0.0			0.0		0.0			0.0	

TABLE 4—*Floc Volume—5-gpm. Filters*

Day	1949												1950	
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
	Filter 10													
1		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
2		0.0		0.0	0.0	0.0	0.0		0.0		0.0	0.0		0.0
3		0.0	0.0		0.0	0.0		trace	0.0	0.0	0.0		0.0	0.0
4		0.0	0.0	0.0	0.0	0.0				0.0	0.0		0.0	
5		trace	0.0	0.0	0.0		0.0	0.0		0.0		0.0	0.0	
6				0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
7			0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
8		trace	0.0	0.0			0.5	0.0	0.0	0.0	0.0	0.0		0.0
9		0.0	0.0	0.0	trace	0.0	0.0	0.0	0.0		trace	0.0	0.0	0.0
10		0.0	0.0		0.0	0.0		0.0	0.0	0.0			0.0	0.0
11		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0			0.0	
12		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	
13				0.0	0.0	0.0	0.0	trace	0.0	0.0		0.0	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	1.0		0.0	0.0	trace	0.0		0.0
15	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
16		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
17		0.0	trace	0.0	0.0	0.0		0.0		0.0	0.0		0.0	0.0
18	0.0	0.0	5.0	0.0	0.0	0.0	0.0	trace		0.0	0.0		0.0	
19		0.0	0.0	0.0	0.0		0.0	trace		0.0		0.0	0.0	
20	0.0			0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0
22	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		
23		0.0	0.0	0.0	0.0	0.0	trace	0.0			0.0	0.0	0.0	0.0
24		0.0	0.0		0.0	0.0		0.0			0.0		0.0	0.0
25	0.0	0.0	0.0	trace	1.0	0.0	0.0	0.0		0.0	0.0		0.0	
26	0.0	0.0	0.0	trace	0.5		0.0	0.0	0.0	0.0			0.0	
27				0.5	1.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
29	0.0		0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0		
30			0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	
31	0.0		0.0		0.0			0.0		0.0			0.0	
	Filter 80													
1		trace	trace			trace	0.0	0.0	0.0	0.0	0.0	0.0		0.0
2		0.0			0.0	0.0	0.0	trace	0.0		0.0	0.0		0.0
3		0.0	0.0		0.0	0.0		trace	0.0	0.0	0.0		0.0	0.0
4	0.0	0.0	0.0		0.0	0.0		trace		0.0	0.0		0.0	
5	trace	0.0	0.0		0.0		0.0	0.0		0.0		0.0	0.0	
6	0.0				0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0
7	0.0		trace		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
8	0.0	trace	0.0			0.0	0.5	0.0	0.0	0.0	0.0	0.0		0.0
9		0.0	trace		trace	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
10		0.0	0.0		0.0	0.0		0.0	0.0	0.0			0.0	0.0
11	0.0	trace	0.0		0.0		0.0	0.0		0.0			0.0	
12	0.0	trace	0.0		0.0		0.0	trace	0.0	0.0		0.0	0.0	
13	0.0				0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
14	0.0	0.0	0.0		0.0	0.0	0.5		0.0	0.0	0.0	0.0		0.0
15	0.0	0.0	trace		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
16		0.0	trace			0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
17		0.0	trace		0.0	0.0		0.0		0.0	0.0		0.0	0.0
18	0.0	0.0	1.0		0.0	0.0	0.0	0.0		0.0	0.0		0.0	
19	0.0	trace	0.0		0.0		0.0	trace		0.0		0.0	0.0	
20	0.0				0.0	0.0	0.0	0.0		0.0		0.0	0.0	0.0
21	0.0	0.0	0.0		0.0	0.0	0.0			0.0	0.0	0.0		0.0
22	trace	0.0			0.0	0.0	0.5	0.0		0.0	0.0	0.0		
23		0.0		0.0	0.0	0.0	0.5	0.0				0.0	0.0	0.0
24		0.0			0.0	0.0		0.0		0.0			0.0	0.0
25	0.0	0.0		trace	5.0	0.0	0.0	0.0		0.0	0.0		0.0	
26	0.0	0.0		trace	0.5		0.0	0.0	0.0	0.0	0.0		0.0	
27	0.0			0.5	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
28	0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0
29	0.0			0.0		0.0	0.0	0.0	0.0		0.0	0.0		
30				0.0		0.0	trace	0.0	0.0		0.0	0.0	0.0	
31	0.0				0.0			0.0		0.0			0.0	

TABLE 5

Coliform Bacteria Counts

Month	Bacteria Count per 100 ml.							
	Low-Rate Filters (Automatic)							
	Filter No.							
	5	15	26	35	45	55	65	75
1949								
Aug.	0.00	0.01	0.01	0.02	0.01	0.04	0.02	0.00
Sept.	0.00	0.00	0.00	0.06	0.03	0.06	0.18	0.15
Oct.	0.00	0.02	0.02	0.01	0.00	0.00	0.00	0.01
Nov.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec.	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01
1950								
Jan.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg.	0.001	0.004	0.006	0.013	0.006	0.014	0.029	0.024
General Avg.	0.012							

Month	4.0-gpm. Rate				4.5-gpm. Rate				5.0-gpm. Rate	
	Filter No.									
	1	21	41	61	11	31	51	71	10	80
1949										
Aug.	0.00	0.00	0.00	0.02	0.00	0.02	0.01	0.01	0.02	0.00
Sept.	0.03	0.00	0.01	0.05	0.00	0.02	0.03	0.06	0.01	0.06
Oct.	0.03	0.01	0.01	0.00	0.04	0.04	0.02	0.01	0.01	0.01
Nov.	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Dec.	0.02	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00
1950										
Jan.	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01
Feb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg.	0.013	0.006	0.003	0.010	0.009	0.013	0.009	0.011	0.011	0.011
General Avg.	0.010									

operated at rates much higher than the designed rate and still produce water of good quality. Now that the coagulation can be strengthened by chemical means to tide over the weak periods, greater economy in filter design may be expected. It is the author's purpose to point out the savings that

will result from a rate of filtration higher than that now commonly used. The conclusions in this paper are based on operating experience with ten high-rate filters in the South Dist. Filtration Plant and on data obtained in the Experimental Filtration Plant, operated from 1928 to 1939.

Assuming the design provides for good mixing and settling, there will be periods in many filtration plants in which the coagulation is so weak that the lengths of filter runs are 50–100 hours or more and other periods in which the filter runs are less than ten hours. Many operators have noted the danger of coagulated material passing through the filters during long runs, particularly after a filter has been in service more than 50 hours. At a 2-gpm. rate, a head loss increase to 8 ft. in 50 hours represents a filter performance of about 800 gal. of water per square foot per foot increase.

When the runs are long and the filter performance is over 800 gal., a close check should be kept on the filtered water to detect the passage of coagulated material. In many filtration plants, the passage of an excessive amount of coagulated material has been avoided by washing the filters after some stated period of service and before the loss of head has reached the maximum. During periods of long runs the operator may wish that the sand were finer, yet he knows finer sand would produce such short filter runs at other times that operation of the plant would be difficult.

The dream of the water chemist has been to be able to strengthen the coagulation by chemical means at will. Until 1936 all efforts along this line had been unsuccessful, except that pH adjustment had proved helpful in waters where the pH was outside the range required for good coagulation.

TABLE 6

Average Cotton Plug Filter Results
(July–December 1949)

Filter No.	Rate* gpm.	Ash ppm.	Filter No.	Rate* gpm.	Ash ppm.
1	4	0.047	41	4	0.051
2	3	0.040	42	3	0.048
3	3	0.040	43	A	0.042
4	3	0.042	44	A	0.044
5	A	0.057	45	A	0.045
6	A	0.038	46	A	0.043
7	A	0.037	47	A	0.045
8	A	0.041	48	A	0.047
9	A	0.040	49	A	0.044
10	5	0.056	50	A	0.043
11	4.5	0.055	51	4.5	0.055
12	3	0.042	52	3	0.053
13	3	0.042	53	3	0.048
14	3	0.044	54	A	0.045
15	A	0.042	55	A	0.046
16	A	0.035	56	A	0.043
17	A	0.040	57	A	0.044
18	A	0.039	58	A	0.046
19	A	0.040	59	A	0.044
20	3	0.037	60	A	0.043
21	4	0.064	61	4	0.059
22	3	0.043	62	3	0.055
23	A	0.042	63	A	0.052
24	A	0.041	64	A	0.061
25	A	0.042	65	A	0.052
26	A	0.048	66	A	0.051
27	A	0.040	67	A	0.054
28	A	0.040	68	A	0.053
29	A	0.046	69	A	0.056
30	A	0.042	70	A	0.049
31	4.5	0.058	71	4.5	0.067
32	3	0.042	72	3	0.054
33	A	0.045	73	A	0.046
34	A	0.045	74	A	0.059
35	A	0.040	75	A	0.047
36	A	0.037	76	A	0.052
37	A	0.044	77		
38	A	0.046	78	A	0.058
39	A	0.048	79	A	0.051
40	A	0.043	80	5	0.075

Avg. 0.047

* "A" indicates filters under automatic rate control.

TABLE 7

Filter Performance

Month	Performance—*mil.gal./ft.*				
	2.0-gpm. Rate				
	Filter 2	Filter 22	Filter 42	Filter 62	Avg.
1949					
Sept.	0.97	0.99	0.83	0.73	0.88
Oct.	0.48	0.49	0.43	0.42	0.45
Nov.	0.66	0.67	0.60	0.53	0.61
Dec.	0.55	0.56	0.45	0.39	0.49
1950					
Jan.	0.42	0.54	0.43	0.43	0.46
Feb.	0.38	0.47	0.40	0.34	0.40
March	1.34	1.25	0.98	0.95	1.13
April	1.09	1.17	0.94	0.97	1.04
Avg.	0.74	0.77	0.63	0.60	0.68

Month	4.0-gpm. Rate				
	Filter 1	Filter 21	Filter 41	Filter 61	Avg.
1949					
Sept.	1.44	1.40	1.29	1.25	1.35
Oct.	0.66	0.67	0.63	0.74	0.68
Nov.	0.71	0.77	0.80	0.80	0.77
Dec.	0.72	0.63	0.58	0.63	0.64
1950					
Jan.	0.57	0.55	0.57	0.65	0.59
Feb.	0.57	0.53	0.52	0.59	0.55
March	1.94	1.53	1.34	1.60	1.60
April	1.63	1.48	1.42	1.59	1.53
Avg.	1.03	0.95	0.89	0.98	0.96

Month	4.5-gpm. Rate				
	Filter 11	Filter 31	Filter 51	Filter 71	Avg.
1949					
Sept.	1.44	1.48	1.38	1.33	1.41
Oct.	0.63	0.68	0.68	0.78	0.69
Nov.	0.71	0.87	0.81	0.83	0.81
Dec.	0.67	0.63	0.70	0.64	0.66

TABLE 7—(*contd.*)

Month	Performance—mil.gal./ft.				
	4.5-gpm. Rate				
	Filter 11	Filter 31	Filter 51	Filter 71	Avg.
1950					
Jan.	0.50	0.63	0.63	0.65	0.60
Feb.	0.49	0.61	0.57	0.58	0.56
March	1.80	1.61	1.48	1.64	1.63
April	1.63	1.68	1.46	1.79	1.64
Avg.	0.98	1.02	0.96	1.03	1.00

Month	5.0-gpm. Rate		
	Filter 10	Filter 80	Avg.
1949			
Sept.	1.53	1.42	1.48
Oct.	0.67	0.78	0.73
Nov	0.79	0.88	0.84
Dec.	0.81	0.62	0.72
1950			
Jan.	0.61	0.70	0.66
Feb.	0.56	0.66	0.61
March	2.03	1.72	1.88
April	1.76	1.78	1.77
Avg.	1.10	1.07	1.09

Development of the silicate method for strengthening coagulation has given the water chemist a new weapon, which may be used to bring about economy and greater efficiency in water treatment and which, above all, permits such close operating control that the only reason for not producing water of the highest quality is employee negligence.

Questions and Answers

The significance of various factors involved in high-rate filtration may best be brought out in question and answer form. The questions are those most often asked the author by water purification chemists and engineers.

1. *How much increase in the filtration rate above 2 gpm. per square foot is recommended?*

A 50 per cent increase is recommended for many waters. The nominal capacity of filters then would be based on a rate of 3 gpm. A filter with 1,400 sq.ft. of sand area would be called a 6-mgd. unit.

2. *What is recommended in the design of filter piping and rate controllers?*

Many of the 2-gpm. filters constructed years ago provided for a

maximum rate of 3 gpm., or 6 mgd. for a 1,400-sq.ft. filter. Some of the newer designs provide for a maximum rate of 3.5 gpm. Although hydraulic conditions generally limit filters of the area stated to a maximum of 6–7 mgd., there are some plants where this rate can be exceeded.

Filter design now should provide easy hydraulic conditions for a 4-gpm. rate. The filter should be capable of being operated at a maximum rate of 5.5–6.0 gpm., with a nominal rating of 3 gpm. The maximum rating would be 83–100 per cent in excess of the 3-gpm. rate. A filter designed for a 2-gpm. nominal rating and capable of being operated at 3.5 gpm. has a maximum rating 75 per cent higher than the nominal.

3. *How much does increasing the filtration rate 50 per cent decrease the lengths of filter runs?*

Tests at Chicago's Experimental Filtration Plant indicated a reduction of 40 per cent. Experience at the South Dist. Filtration Plant indicates the reduction to be about 35 per cent.

4. *What is the increase in the amount of wash water required for the 50 per cent increase in the filtration rate?*

The experimental plant data indicated that 1.75 per cent wash water was required at the 2-gpm. rate and 1.95 per cent at the 3-gpm. rate, a difference of 0.20 per cent. Results at the large plant indicate that the difference is less. In fact, many of the data show a lesser percentage of wash water for the high-rate filters than for the low-rate filters.

5. *Assuming there is a difference of 0.20 per cent in favor of the low-rate filters, as indicated by the experimental plant data, what is the extra cost for wash water in a plant handling 300 mgd.?*

The chemical and pumping costs at the South Dist. Plant averaged about $5.00 per million gallons in 1949, and the wash water pumping cost was $3.00 per million gallons. The extra cost would amount to $1,750 a year, which is about 0.126 per cent of the plant operating cost, or about 1.5¢ per million gallons. The actual wash water cost was considerably less, with the data indicating that there may have been a slight saving instead of an increase in cost resulting from the high-rate filtration.

6. *Why was the actual wash water cost considerably less than 1.5¢ per million gallons?*

After some experience in operating filters at the South Dist. Plant, it was concluded that those with less than 8 ft. loss of head should be washed after 48 hours of service. During a portion of the year, therefore, the low-rate filters are washed before the loss of head increases to 8 ft. The period in which the high-rate filters are washed at a head loss of less than 8 ft. is much shorter. A major factor is the proportionally greater filter performance of the high-rate units.

7. *Why is the filter performance greater for the high-rate filters than for the low-rate filters?*

This question cannot be answered definitely at present. In general, one would expect the filter performance to be the same regardless of rate or perhaps slightly less for the high rate. It may be, however, that the rapid flow of water into the filter causes deeper penetration of the coagulated material.

8. *If the above assumption is correct, would not the high-rate filters pass coagulated material more readily than the low-rate filters?*

They would. Any plant contemplating high-rate filtration should test one or two filters at high rates quite thoroughly before adopting such rates for the entire plant.

9. *How is the passage of coagulated material avoided in the South Dist. Filtration Plant?*

Acid-treated sodium silicate is added to the water during periods when the coagulation would be weak enough to cause a small amount of coagulated material to pass through the filters.

10. *Does the silicate treatment involve added cost?*

There is some extra cost involved, although the saving in aluminum sulfate generally overbalances the expense of adding silicate.

11. *Would it be necessary to provide for the silicate treatment with low-rate filtration?*

Silicate treatment would be necessary for the Lake Michigan water used at Chicago but perhaps not for many other waters. Because of the wide variation in the strength of the coagulation of Lake Michigan water at different times of the year, sand fine enough to filter the water clear during periods of weak coagulation would be too fine for practical operation of the plant when large growths of microscopic organisms were present. It was difficult to cope with this situation before a means of strengthening the coagulation was developed. With most waters, provision for the use of high-rate filtration should include some method of strengthening the coagulation when needed.

12. *What is the cost of the silicate treatment in the large filtration plant?*

In 1949 the expense, omitting capital cost, was 6¢ per million gallons for both sodium silicate and sulfuric acid, or a yearly total of $6,253. Although no attempt has been made to estimate the value of the aluminum sulfate saved, it probably was in excess of $5,000. The significant fact is that high-rate filtration produced a better quality of water during the periods of weak coagulation than would be possible with filters of finer sand operated at a maximum rate of 2 gpm.

13. *Following customary filtration practice, what would have been the effective size of filter sand considered satisfactory for low-rate filtration?*

It is believed that an 0.50-mm. diameter would have been recommended for the effective sand size.

14. *What is the effective size of sand used in the South Dist. plant?*

The effective size is 0.65–0.70-mm. diameter.

15. *How much increase in the length of filter runs should be expected for sand of 0.65-mm. diameter, as compared with sand of 0.50-mm. diameter?*

The data from the experimental plant indicated that the length of the filter runs increased 75–100 per cent.

16. *Does this lengthening of filter runs aid in operation?*

It does during the periods of short filter runs. The time between washings is longer and there is a direct saving in the amount of wash water used. Since all of the filters in the South Dist. Plant use the coarser sand, exact comparisons cannot be made.

17. *What is the estimated saving in wash water cost due to using coarser filter sand at the South Dist. plant?*

If it is assumed that there is a saving of 25 per cent in the amount of wash water and that it costs $8.00 per million gallons to treat and pump this wash water, the saving would come to about $4,264 annually.

18. *What is the saving in the cost of a filtration plant designed for a 3-gpm. instead of a 2-gpm. rate?*

The saving will vary but would probably average at least 5 per cent.

19. *Why is the saving no greater than 5 per cent?*

Parts of the plant other than the filters should not be decreased in size. The water should be properly coagulated and the period of settling should be such as to give adequate sedimentation. The saving, therefore, is only in the construction cost of the filters. The piping and rate controllers should be larger. The saving at the South Dist. Filtration Plant amounted to at least $1,000,000. Two per cent interest on this sum is $20,000 annually.

20. *Does the use of coarse sand, high-rate filtration and acid-treated sodium silicate insure the production of a good-quality water?*

The data presented herewith show conclusively that it does. In any plant where tests indicate a reduction in water quality, high-rate filtration is not recommended.

Conclusions

The reason for using high-rate filtration is its economy. If cost were not a consideration, filter design could be based on a 1-gpm. rate. It is agreed by all that cost is next in importance to water quality. The 2-gpm. rate is widely used because practice has proved that water of good quality can be produced at this rate more cheaply than at a lesser rate. But many plants are demonstrating that 3- and 4-gpm. rates may be employed without lowering the water quality. When the demand for water is high, no one now hesitates to run the filters at rates higher than 2 gpm. Usually the high demand lasts only a few hours a day and occurs in the summer, when the coagulation is generally the strongest. During the summer the filters in nearly every plant in the United States can be operated at the maximum limit of the filter control apparatus with no appreciable lessening of the quality of the water.

The 2-gpm. rate of filtration was set more than 50 years ago. At that time water was poorly conditioned because mixing basins generally were not provided or were very small and the period of sedimentation was short in many plants. The requirements for optimum floc formation were unknown. Chlorination was almost unheard of and was not used in any filtration plant. Filtration rate practice is still in the nineteenth century. It would seem strange if all that has been learned about conditioning water in the past 50 years could not improve this situation. For many plants, the only stumbling block in the way to higher rates of filtration has been the periods of weak coagulation in the winter. Now that a means of strengthening coagulation has been found, such an obstacle no longer exists.

In a plant designed for a 2-gpm. rate of filtration, operation at a 4-gpm. rate would cut the mixing and settling periods in half and would naturally cause the discharge of considerably more coagulated material to the filters. If, however, the filter area were designed on the basis of a 3-gpm. rate, with 30 minutes' mixing and three hours' settling, increasing the rate to 4 gpm. at times of high demand would still permit very satisfactory periods of mixing and settling. It should be pointed out that many existing plants cannot be converted to high-rate filtration because of their hydraulic limitations.

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Rockford Ground Water Situation

By H. F. Smith

A paper presented on April 14, 1950, at the Illinois Section Meeting, Chicago, by H. F. Smith, Assoc. Engr., State Water Survey Div., Urbana, Ill.

IN recent years attention has been focused on the lowering of ground water levels at a number of centers in Illinois. Some have feared that ground water supplies are nearing exhaustion. A large part of this concern has resulted from the persistent decline of the water levels in pumped wells in locally overdeveloped areas. In such regions, investigations are being made by the Illinois State Water Survey Div. to find practical measures to alleviate the condition.

At the request of H. S. Merz, Supt., Rockford, Ill., Water Dept., an investigation was made in Winnebago County, which is situated about midway along the northern border of Illinois. Field studies began in September 1947 and ended in January 1948. The purpose of the investigation was to determine the quality, quantity, movement and availability of ground water and the feasibility of further development. The study was based on an inventory of the major producing wells in the Rockford area, including all wells with facilities capable of producing more than 50 gpm. Pumpage, well water levels and other hydrologic data were collected. Pumping tests on one city-owned and three industry-owned wells were conducted to determine coefficients of transmissibility and storage.

Waters from 34 wells were sampled for chemical analysis in order to characterize the supplies from the various sources. From the chemical data, the waters were classified as originating from three primary sources: sandstone, pre-Wisconsin drift and local recharge. These classifications have been used to assist in interpreting the hydrologic data by indicating the sources of water obtained at the various wells.

Except in a few places, the glacial drift deposit covering Winnebago County is not heavy (1), and the original topography has, therefore, not been greatly modified. The land, as a whole, is gently rolling, although the numerous streams have cut it up considerably. The drainage of the county is effected by the Rock River and its tributaries. The Rock River enters a preglacial valley near Janesville, Wis., and follows it southward a distance of 50 miles to the mouth of the Kishwaukee River a few miles below Rockford (2).

Pumpage and Water Levels

Most of the ground water withdrawal in Winnebago County is at Rockford. From 1885 to 1948 all the water pumped by the municipality has been from wells 1,100–1,600 ft. deep which penetrate sandstone, with the casings extending to bedrock. The

more recently constructed wells are capable of producing in excess of 1,500 gpm. The average municipal pumpage increased from 7.18 mgd. in 1940 to 12.95 mgd. in 1947, a rise of 80 per cent in seven years. There was a 9 per cent decrease in nonmunicipal pumpage between 1943 and 1948. The average nonmunicipal pumpage for 1947 was 12.48 mgd., of which 11.41 mgd. was from wells penetrating sandstone, the remainder coming from wells finished in the glacial drift.

Figure 1 shows the water pressure contours of the St. Peter and Cambrian sandstones at Rockford and vicinity. The contours were based on measurements of the elevations of water levels in the wells of the area.

As little, if any, difference is now noted in the water levels of the different sandstones, no separation of the water levels was made. Many of the observed wells penetrate both the St. Peter and the Cambrian sandstones, and any original difference in the artesian pressure of the various sandstones has apparently been equalized.

Movement of Ground Water

The movement of ground water depends on two conditions: the saturated material must be permeable and there must be a force (hydraulic gradient) to cause the water to move. The flow of the ground water is directly proportional to the permeability of the water-bearing stratum, the hydraulic gradient and the cross-sectional area of the material through which the water moves.

The direction of movement of the ground water is at right angles to the water pressure contour lines. Thus,

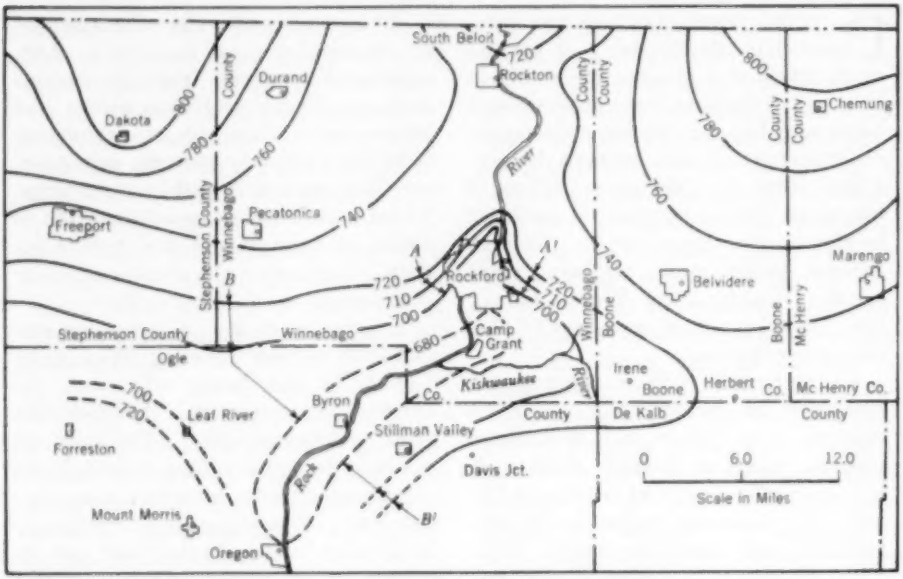

FIG. 1. Water Pressure Contour Map

the ground water movement at Rockford and vicinity, based on the contour map, is toward Rockford from the uplands in the northwest and the northeast. To determine the hydraulic gradient, the contour interval is divided by the distance between contour lines.

The contour map shows a small cone of depression in the industrial area in the southeastern part of Rockford, which includes the city's Unit Well No. 7. Below this, a much larger cone of depression is found, extending from the southern limits of Rockford to Oregon and including the Rock River between the two cities.

For convenience, the term "coefficient of transmissibility," expressed in gallons per day, is used to indicate the product of the field coefficient of permeability and the thickness of the saturated aquifer.

During this investigation four pumping tests were made. In each test, it was possible to observe the interference in a nearby well. The results of these tests were analyzed by means of a formula originated by Theis (3) and further developed by Wenzel (4).

The value of the coefficient of transmissibility of the bedrock aquifers ranged from 55,500 to 118,300 gpd. and averaged about 90,000. Using the Theis method, values were obtained for the coefficient of storage in the four interference pumping tests. These values ranged from 0.00001 to 0.00006, with most at about 0.00005. Consequently, a figure of 0.00005 was used in making calculations.

The above storage coefficient values are considerably lower than the 0.0004 average found in tests at Chicago, indicating that much less water is being derived from storage at Rockford. The lower values at Rockford may possibly be explained by the almost stationary artesian pressure head. The calculations were based on data obtained at locations where the head had fluctuated many times through the range recorded in the tests.

If the extent of the water-producing formations and the coefficients of transmissibility and storage are known, the future decline of the water level and the interference between wells can be estimated. The curves in Fig. 2 show theoretical drawdowns—computed according to the Theis method—which are the result of pumping a well at a constant rate of 1 mgd., the aquifer having a coefficient of transmissibility of 90,000 gpd. and a coefficient of storage of 0.00005.

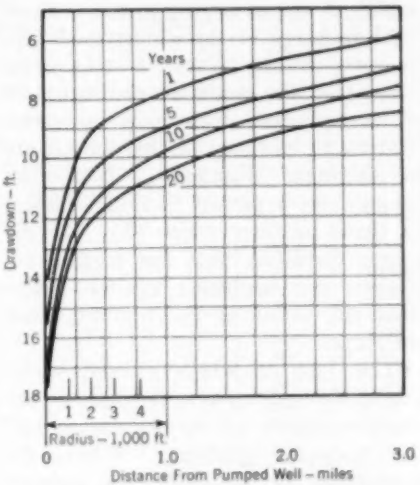

FIG. 2. Theoretical Drawdowns

Available Ground Water

The quantity of water that can be withdrawn from the water-bearing formations depends on the amount of rainfall which percolates into them in

their outcrop areas, the capacity of the formations to transmit the water to the pumped areas and the amount of water withdrawn from storage in the formations when the head is reduced. In the Rockford area, except for the wells within the local cone of depression, the water level elevations in the sandstone wells are higher than those of the overlying gravel and of the Rock River water surface. In the cone of depression, the sandstone hydrostatic pressure is somewhat less than that of waters in the overlying gravel. Some local recharge of the sandstone is apparently taking place in this area. Otherwise, the sandstone receives most of its recharge at the outcrop areas. The major portions of these areas are in southern Wisconsin. Numerous springs are reported in and adjacent to these outcrop areas (5). It appears, therefore, that the rainfall recharges the sandstone aquifers faster than the water is transmitted down the slope.

The rate at which ground water moves through an area depends on the transmissibility of the formation and the hydraulic gradient. Within the boundaries of Rockford, the contour having an altitude of 710 ft. above sea level (*see* Fig. 1) was chosen as the line along which the rate of inflow could be most readily and accurately determined. The length of this line (*A–A'*) between the east and west city limits is 11 miles, the average hydraulic gradient across this contour is 25 ft. to the mile and the average coefficient of transmissibility was taken as 90,000 gpd. On the basis of these estimates, the 1947 inflow across the 710-ft. contour into Rockford was computed as 24.75 mgd. Apparently not all of this flow is diverted at Rockford, as the hydraulic gradient continues downgrade to the south and southwest. The pumpage from sandstones in the area was 24.36 mgd., an amount substantially equal to the sandstone inflow. The continued "through flow" indicated by the map is believed to be due to the unconsolidated valley fill within Rockford and to withdrawals from storage in the sandstones.

To determine the sandstone inflow into the Oregon-Rockford region, the 700-ft. contour was used. The length of this line from the west boundary of Winnebago County to below Stillman Valley (*B–B'*), exclusive of that portion within the city of Rockford, is 45 miles, the average hydraulic gradient across the contour is 7 ft. to the mile and the average coefficient of transmissibility was taken as 90,000 gpd. The sandstone inflow into the region across the 700-ft. contour, exclusive of the Rockford flow, was then calculated to be 28 mgd. As the pumpage within the 680-ft. contour outside of Rockford is not more than 1 mgd., it appears, from ground water considerations alone, that approximately 27 mgd. is being discharged from the sandstones in this region.

Weidman and Schultz (5) state that, at Beloit, Wis. (adjoining South Beloit, Ill.), the depth of the drift is very irregular, but it seems very probable that a considerable portion of sandstone water is fed directly to the gravel and porous beds of the drift by the underlying St. Peter sandstone in which the preglacial valleys were eroded.

This estimate of ground water discharge can be checked by a study of surface water flow conditions. An examination of flow records (6) for the Rock River between Rockton and Ore-

gon showed that the minimum recorded flow at Oregon occurred between August 21 and 31, 1941. The flow rates for this period are given in Table 1.

It was assumed that during the period of minimum flow, following six consecutive days of little or no precipitation, practically all of the increase in flow was of ground water origin. Inspection of the data in Table 1 shows that the sector of the Rock River between Rockford and Oregon contributed several times as much to the river flow (per unit drainage area) as other sectors. Other low-flow periods showed similar effects. A flow–drainage area ratio of 0.340 mgd. per square mile is shown for that part of the Rock River between Rockton and Oregon, compared with a ratio of 0.1089 for the entire watershed above Oregon and 0.0936 above Rockton. The difference between these ratios indicates an increased contribution of ground water for the Rockford-Oregon segment, amounting to about 70 mgd.

If the rate of pumping in the neighborhood of Rockford is increased substantially, the hydrostatic pressure of the sandstone will decrease and much of the water now being discharged into

TABLE 1

Stream Flow Analysis

Date (Aug 1941)	Rock R. at Rockton	Rock R. at Oregon	Leaf R. at Leaf River	Kishwaukee R. at Perryville	Kilbuck Creek at Monroe Center	Oregon*	Oregon* Minus Rockton (1-day Interval)
	Drainage Area—*sq.mi.*						
	6,290	8,120	102	1,090	114	6,813	524
	Flow—*mgd.*						
21	591	944	8	106	3	827	
22	612	944	7	101	3	833	242
23	594	879	7	92	3	777	165
24	456	879	7	88	3	781	187
25	698	769	10	101	4	654	198
26	575	1,015	10	116	3	886	188
27	585	944	8	101	3	832	257
28	659	944	8	88	3	845	260
29	618	821	8	80	3	730	71
30	586	821	7	77	2	735	117
31	465	769	6	78	2	683	97
Avg.	585	884	8	93	3	780	178
Ratio of flow to drainage area	0.0936	0.1089	0.0784	0.0853	0.0263	0.1145	0.340

* Rock R. flow at Oregon minus Leaf R. flow at Leaf River, Kishwaukee flow at Perryville, and Kilbuck Creek flow at Monroe Center.

the streams will become available as ground water.

No attempt has been made to analyze the availability of water from the overlying sands and gravels, as sufficient data are not at hand. There are, however, indications that the sand- and gravel-filled preglacial valley has a very large potential safe yield. This valley is 3–5 miles wide and is more than 300 ft. deep in some places.

Acknowledgment

The author is indebted to many owners for valuable information regarding their wells, and especially to the Quaker Oats Co., the George D. Roper Corp. and the Woodward Governor Co. for allowing measurements of flow and water level fluctuations in their wells. The well drillers, especially Charles W. Varner and I. B. Null, also furnished data.

Credit is due in particular to H. S. Merz, Supt., Rockford Water Dept., who made its records available and furnished certain labor and material during the investigation; also to the various employees of the Illinois State Water Survey Div. who from time to time secured certain information used in this report. The conscientious, careful work of J. B. Millis, Field Engr., is deeply appreciated.

The study was carried on under the supervision of H. E. Hudson Jr., Head, Engineering Subdiv., and A. M. Buswell, Chief, Illinois State Water Survey.

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1950

American Water Works Association

Tentative
STANDARD SPECIFICATIONS
for
BAUXITE

These "Tentative Standard Specifications for Bauxite" are based upon the best known experience and are intended for use under normal conditions. They are not designed for use under all conditions and the advisability of use of the material herein specified in any water treatment plant must be subjected to review by the chemist/engineer responsible for operations in the locality concerned.

Approved as Tentative by the Board of Directors of the A.W.W.A. on April 28, 1950

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These "Tentative Standard Specifications for Bauxite" were prepared under the direction of C. K. Calvert (deceased) and J. E. Kerslake of the Water Purification Division, A.W.W.A. The specifications were approved by the officers of the Water Purification Division and were submitted for review to producers and consumers of the materials involved, whose comments were then considered by Edward S. Hopkins, acting as referee. The text as finally edited was approved by the Committee on Water Works Practice and received the approval of the Association's Board of Directors on April 28, 1950.

Tentative

Standard Specifications for Bauxite

Part A—Material Specifications

Sec. 1A—Scope

These specifications cover bauxite for use in the treatment of municipal and industrial water supplies. The specifications are intended for use in connection with Part B (Sampling, Inspection, Packing and Marking) and Part C (Testing Methods) of this document.

Sec. 2A—Definition

Bauxite is a mineral containing a preponderance of hydrated aluminum oxide. Its content varies considerably with respect to the aluminum oxide, iron and silica.

Sec. 3A—Sampling

Sampling shall be conducted in ac cordance with Part B (Sampling, Inspection, Packing and Marking) of this document.

Sec. 4A—Methods of Testing

The analytical procedures shall be carried on in accordance with Part C (Testing Methods) of this document.

Sec. 5A—Impurities

The bauxite supplied under these specifications shall contain no soluble mineral or organic substances in quantities capable of producing deleterious or injurious effects upon the health of those consuming the water which has been treated properly with compounds made from it.

Sec. 6A—Rejection

6A.1. Notice of dissatisfaction with a shipment, based on the specifications, must be in the hands of the consignor within ten days after receipt of the shipment at the point of destination. If the consignor desires a retest, he shall notify the consignee within five days of notice of the complaint. Upon receipt of the request for a retest, the consignee shall forward to the consignor one of the sealed samples. In the event that the results obtained by the consignor on retesting do not agree with the results obtained by the consignee, the other sealed sample shall be forwarded, unopened, for analysis to a laboratory agreed upon by both parties. The results of the referee analysis shall be accepted as final and the cost of the referee analysis shall be paid for by the party whose results show the greatest discrepancy from the referee results.

6A.2. On the basis of the retest or the referee test, the consignor may remove the material from the premises of the consignee or a price adjustment may be agreed upon by the consignor and consignee.

Sec. 7A—Size

The material shall be crushed to lumps not greater than 2 in. in diameter.

Sec. 8A—Chemical Composition

8A.1. The moisture content shall not exceed 3 per cent.

8A.2. Loss on ignition shall not exceed 25 per cent.

8A.3. The silica (SiO_2) content shall not exceed 15 per cent.

8A.4. The total iron as Fe_2O_3 shall not exceed 5 per cent.

8A.5. The aluminum oxide (Al_2O_3) shall be not less than 55 per cent.

8A.6. The titanium oxide (TiO_2) shall not exceed 5 per cent.

Part B—Sampling, Inspection, Packing and Marking

Sec. 1B—Scope

These procedures for the sampling, inspection, packing, weighing and marking of bauxite are intended for use in connection with Part A (Material Specifications) and Part C (Testing Methods) of this document.

Sec. 2B—Sampling

2B.1. Samples shall be taken at the point of destination.

2B.2. If the bauxite is handled by conveyor or elevator, a mechanical sampling arrangement may be used.

2B.3. If the material is packaged, 5 per cent of the packages shall be sampled by the use of a "thief." No sample shall be taken from a broken package.

2B.4. Samples shall be taken with great care to avoid a disproportionate amount of material from the top or bottom, and the size of particles in the sample shall be as nearly as possible the same as in the entire shipment.

2B.5. The gross sample, weighing at least 10 lb., shall be crushed, if necessary, and mixed thoroughly and quartered to provide three 1-lb. samples. They shall be sealed in airtight, moistureproof glass containers. Each sample container shall be labeled to identify it and the label shall be signed by the sampler.

Sec. 3B—Packing and Shipping

3B.1. Bauxite may be shipped in bags, barrels or bulk, in boxcars. Cars must be tight and well cleaned before loading.

3B.2. The net weight of packages shall not deviate from the recorded weight by more than 2.5 per cent, plus or minus. If exception is taken to the weight of the material received, it shall be based on a certified unit weight of not less than 10 per cent of the packages shipped, selected at random from the entire shipment.

Sec. 4B—Marking

Each shipment of material shall carry with it some means of identification. Each package shall have marked legibly thereon the net weight of the contents, the name of the manufacturer and a brand name, if any. The package may bear also the statement: "Guaranteed by (name of manufacturer) to meet the specifications of the American Water Works Association for bauxite."

Part C—Testing Methods

Sec. 1C—Scope

These methods for the examination of bauxite are intended for use in connection with Part A (Material Specifications) and Part B (Sampling, Inspection, Packing and Marking) of this document.

Sec. 2C—Sampling

2C.1. Sampling shall be conducted in accordance with Part B (Sampling, Inspection, Packing and Marking) of this document.

2C.2. The sample delivered to the laboratory shall be divided into at least two parts, one of which shall be quartered to approximately 100 g. and this amount reduced by mechanical grinding, or in a mortar by hand, to such size that all of it passes a 100-mesh sieve. After thorough mixing, the sample shall be dried to constant weight at 105°C., stored in an airtight glass container and weighed rapidly from the container to avoid change in moisture content.

2C.3. The laboratory examination of the sample shall be completed within five working days after receipt of the shipment.

Sec. 3C—Moisture

3C.1. *Procedure.* Weigh 10 g. of the sample as received in the laboratory (before grinding) and dry in a wide, flat weighing bottle or dish at 105°C. to constant weight. Cool in a desiccator and weigh.

3C.2—*Calculation:*

$$\frac{\text{Loss of weight}}{\text{Weight of sample}} \times 100 = \text{per cent moisture.}$$

Sec. 4C—Loss on Ignition

4C.1—*Procedure.* Weigh 1 g. of the dried sample in a tared covered crucible and heat gently in a muffle furnace and with gradually increasing temperature to 1,100°C. (bright red), at which temperature it shall be held for one-half hour. Re-ignite to constant weight.

4C.2—*Calculation:*

$$\frac{\text{Loss of weight}}{\text{Weight of sample}} \times 100 = \text{per cent loss on ignition}$$

Sec. 5C—Silica

5C.1—*Reagents:*

(a) Acid mixture—485 ml. of distilled water, 115 ml. of concentrated sulfuric acid, 200 ml. of concentrated hydrochloric acid, 200 ml. of concentrated nitric acid

(b) 1 : 1 sulfuric acid by volume

(c) 48 per cent hydrofluoric acid

5C.2—*Procedure:*

5C.2.1. Treat 1 g. of the dried sample in a medium-size casserole or pyrex beaker with 60 ml. of the acid mixture [5C.1 (a)]. Cover and heat slowly until the liquid is driven off and sulfur trioxide fumes have been evolved for some time.

5C.2.2. By pouring gently down the side of the casserole, using the watch glass to protect from spattering, add approximately 100 ml. of cold distilled water and heat to boiling. Filter, using quantitative paper, into a 250-ml. flask and wash the residue carefully. Keep the filtrate for subsequent analysis as directed below. (For accurate work, the dehydration and filtration should be repeated).

5C.2.3. Ignite the precipitate to bright-red heat in a platinum crucible and cool in a desiccator. Weigh the cooled crucible as rapidly as possible. Ignite an additional fifteen minutes at bright-red heat, continuing to do so until constant weight is obtained. Moisten the residue in the platinum crucible with a few drops of 1 : 1 sulfuric acid and add hydrofluoric acid. Evaporate to dryness carefully, ignite and weigh. On unknown samples, it is well to repeat the treatment with sulfuric acid and hydrofluoric acid until no further loss occurs.

5C.3—*Calculation:*

$$\frac{\text{Loss of weight}}{\text{Weight of sample}} \times 100 = \text{per cent silica } (SiO_2)$$

Sec. 6C—Treatment of Silica Residue

6C.1. *Reagent.* Potassium acid sulfate.

6C.2. *Procedure.* For very accurate work, the residue from the hydrofluoric acid treatment should be fused thoroughly with about 1 g. of potassium acid sulfate. After fusion, cool and dissolve in water containing a little 1 : 1 sulfuric acid, heat to boiling, filter if necessary and add to the filtrate from the silica determination (5C.2.2). Fill the flask to the mark after cooling and mix thoroughly.

Sec. 7C—Aluminum Oxide

7C.1—*Reagents:*

(a) Concentrated hydrochloric acid

(b) Concentrated nitric acid

(c) Ammonium hydroxide, diluted 1 : 1 with distilled water

(d) Methyl red indicator—dissolve 1 g. in 500 ml. of neutral 95 per cent alcohol

(e) Washing solution—dissolve 20 g. of ammonium chloride in 1 liter of distilled water

7C.2—*Procedure:*

7C.2.1. Measure 50 ml. of the filtrate from the silicate determination into a 250-ml. beaker and dilute to approximately 200 ml. with distilled water.

7C.2.2. Add 5 g. of ammonium chloride and stir until dissolved.

7C.2.3. Add 2 ml. of concentrated hydrochloric acid and 4 ml. of nitric acid and boil gently for a few minutes to oxidize the iron.

7C.2.4. Prepare quantitative filter papers in the funnels, have the washing solution hot and bring the samples to near boiling.

7C.2.5. Add the diluted ammonium hydroxide slowly until a precipitate starts to form.

7C.2.6. Add the methyl red indicator and continue the addition of the ammonium hydroxide, dropwise, until the first appearance of a yellow color.

7C.2.7. Boil the samples for one minute. (Long boiling or standing before filtering causes the precipitate to become slimy, which prolongs filtration.)

7C.2.8. Filter immediately, using a double filter paper and keeping the filter papers nearly full to expedite filtration. Using the washing solution, transfer all of the precipitate from the beakers to the papers and wash the precipitate into the apex of the paper. Continue washing until the wash water is free from sulfate. Save the filtrate for determination of foreign sulfates.

7C.2.9. Place the filter paper and contents, apex up, in a tared platinum crucible and ignite in a muffle furnace at dull-red heat until all carbon is burned off, after which the ignition

should be completed at bright-red heat for an hour.

7C.2.10. After ignition, the crucible shall be immediately covered and cooled in a desiccator over sulfuric acid. Weigh the cooled, covered crucible as rapidly as possible. Ignite an additional fifteen minutes at bright-red heat, continuing to do so until constant weight is obtained. The weight of the residue represents the aluminum, titanium and iron oxides.

7C.3—*Calculation:*

$$\frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100 = \text{per cent mixed oxide}$$

7C.4. The mixed oxide consists of the oxides of aluminum, iron, titanium, zirconium, phosphorus and so forth. For routine work, the mixed-oxide figure may be corrected by the subtraction of only the oxides of iron and titanium, but, for especially accurate work, other oxides must be determined and deducted.

Sec. 8C—Titanium Oxide

8C.1. *Apparatus.* Any satisfactory commercial colorimeter or Nessler comparator tubes may be used.

8C.2—*Reagents:*

(a) 1:1 sulfuric acid by volume

(b) 3 per cent hydrogen peroxide (for subsequent use after opening, store in a cool place)

(c) Standard titanium sulfate solution, prepared as follows: weigh out exactly 2.216 g. cp. recrystallized potassium titanium oxalate, $K_2TiO(C_2O_4)_2 \cdot 2H_2O$, into a 500-ml. Erlenmeyer flask, add 8 g. ammonium sulfate and then 100 ml. concentrated sulfuric acid; heat gently to boiling and boil for ten minutes to free solution from oxalic acid; cool and cautiously dilute with water to 1,000 ml. (1 ml. = 0.0005 g. TiO_2)

8C.3—*Procedure:*

8C.3.1. Place 25 ml. of the filtrate from the silica determination (6C.2) in a 100-ml. volumetric flask, add 10 ml. of 1:1 sulfuric acid and 3 ml. of 3 per cent hydrogen peroxide. Fill to the mark with distilled water and mix.

8C.3.2. Match the color produced in the colorimeter by approaching the matching point from the stronger and then from the weaker side in sequence. Then average the readings taken.

8C.3.3. In the absence of a colorimeter, place 10 ml. of 1:1 sulfuric acid in a 100-ml. Nessler tube, add 3 ml. of 3 per cent hydrogen peroxide and water to just below the mark. Add unperoxidized titanium sulfate solution to the tube until the color matches that of the unknown in which the color has been developed as specified in 8C.3.1.

8C.4—*Calculation:*

$$\frac{\text{Weight of titanium oxide}}{\text{Weight of sample}} \times 100 = \text{per cent titanium oxide } (TiO_2)$$

Sec. 9C—Total Iron Oxide

9C.1—*Reagents:*

(a) Concentrated hydrochloric acid

(b) Preventive solution—160 g. manganous sulfate, 330 ml. of 85 per cent phosphoric acid, 320 ml. of sulfuric acid and 1,750 ml. of water

(c) 1 per cent potassium permanganate solution

(d) 5 per cent stannous chloride in 1:1 hydrochloric acid

(e) Saturated solution of mercuric chloride

(f) 0.05*N* potassium permanganate, standardized against iron

9C.2—*Procedure:*

9C.2.1. To the remaining portion (175 ml.) of the filtrate from the silica determination (6C.2) add a few drops of potassium permanganate solution and concentrate to 50–75 ml.

9C.2.2. Add 20 ml. of hydrochloric acid and bring to boiling. Reduce the iron by adding, dropwise, concentrated stannous chloride solution until the yellow color of the ferric chloride disappears. The endpoint is sharp, and not more than two drops of stannous chloride should be added in excess.

9C.2.3. Cool the solution to room temperature, add 5 ml. of the saturated solution of mercuric chloride and stir thoroughly. A small, white precipitate should form slowly, indicating a slight excess of stannous chloride.

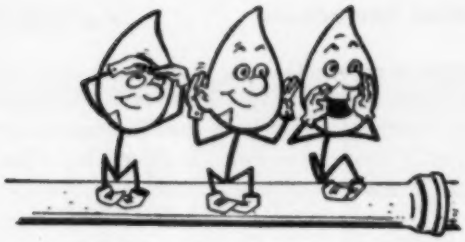
9C.2.4. Dilute to 150–200 ml. and titrate with 0.05*N* potassium permanganate solution to an initial pink color which does not fade within fifteen seconds.

9C.3—*Calculation:*

$$\frac{\text{ml. of } 0.05N \text{ } KMnO_4 \times 0.00399}{\text{Weight of sample}} \times 100 = \text{per cent iron oxide } (Fe_2O_3)$$

Erratum

In the paper "Effect of Partial Demineralization of Water on Bacteria," by K. S. Spiegler and Esther Hellinger, which appeared in the April 1950 JOURNAL (Vol. 42, p. 412), Paragraph 2 of the "Summary" contains an error. The bacterial count of the raw water is given as "1,000 *Esch. coli* per milliliter." The correct figure is 1,000,000 *Esch. coli* per milliliter.



Percolation and Runoff

Word of Philadelphia's new record is by now more record than news, but we owe at least mention of the fact that the City of Brotherly Love played host to the first "over 2,000 registration" from the first "over 8,000-member A.W.W.A." in history. As a matter of fact, historic Philadelphia was the site of a lot of new history during the Conference when the Association entered its 70th year and the local water department its 150th. And both Doc Black's swan song salute to A.W.W.A. in mid-century and Vic Weir's inaugural accent on youth gave promise that more history is in the making and that more milestones will be passed more often.

But the 1950 Conference was more than a historic highspot; it was an overall success which featured more exhibits, more technical sessions, more inspection trips, more entertainment than ever before. With ninety odd exhibitors spreading their wares in some 150 booths, registrants had an unparalleled opportunity to stop and shop at the most super market ever set up in the water works field. With a hundred scheduled speakers on a program that covered all the vital interests of the field, information burgeoned. With 18 separate excursions to Philadelphia's Belmont, Torresdale and Queen Lane plants and one to the new Chester Municipal Authority works, almost no one missed a chance for a postman's holiday. And with social functions every evening for everybody and every afternoon as well for the ladies—plus a chance to play golf at the club that was host to this year's National Open—a dull time was had by no one.

As always, a new year brought forth a new galaxy of awardees and prize-winners. Thus, beginning on Wednesday's "Award Night," the following honors earners were saluted: Honorary Members Jack Hinman, John Murdoch and George Pracy; Diven Medalist Joe Schwada; and the Goodell Prize-winning fluoridation committee chairmanned by Doc Black. Also 18 of this year's 26 Fuller Awardees were on hand to accept their certificates and make their bows. Then Thursday's dinner started out as something of a western sandwich when the Arizona Section took possession of both Hill and Henshaw cups and the California Section pulled its annual surprise victory in the competition for the Old Oaken Bucket. The surprise, of course, was the fact that, having bestowed two cups and a presidential buss upon Arizona's Helen Rotthaus, our Floridian Prexy appar-

(Continued on page 2)

(Continued from page 1)

ently found California's Bill Aultman somewhat less kissable and ducked his own precedent by merely announcing that section's twelfth consecutive victory. Even that wasn't the end of western winners, however, for when the Photography Contest prizes were handed out it was photomicrographer George Turre of Denver, Colo., and construction cameraman M. J. Shelton of La Mesa, Calif., who took first in their classes, leaving the East to be content with a first in the operations class by Julius Nido of Waterbury, Conn., and the South with one in the general interest division by C. R. Henry of Miami (see pages 10–14). Finally, among many prizes to divot

A smiling W. Victor Weir takes over the cares of the A.W.W.A. Presidency from A. P. Black, as Vice-President Albert E. Berry and Philadelphia host Elbert J. Taylor look on.

diggers of every level of excavation, it was J. F. Laboon who took the cup with a low net score of 72; and Ralph Tyler who turned in the low gross of 79. Peddler pros were two Lock Jointers, Larry Seton with a low gross of 76 and Harvey Stowe with a low net of 70.

Those were by no means all the highlights of the overall program worked out by Sig Sigworth, Tom Quigley, Casey Jones, Bert and Mrs. Bert Taylor, Charlie Capen and Frank Friel and the committees which worked under them. Mention should be made, for instance, of the return of George Hagerty, the misplaced minstrel, and of the introduction of the Rockwell Male Chorus, who entertained on Thursday night around the

(Continued on page 6)

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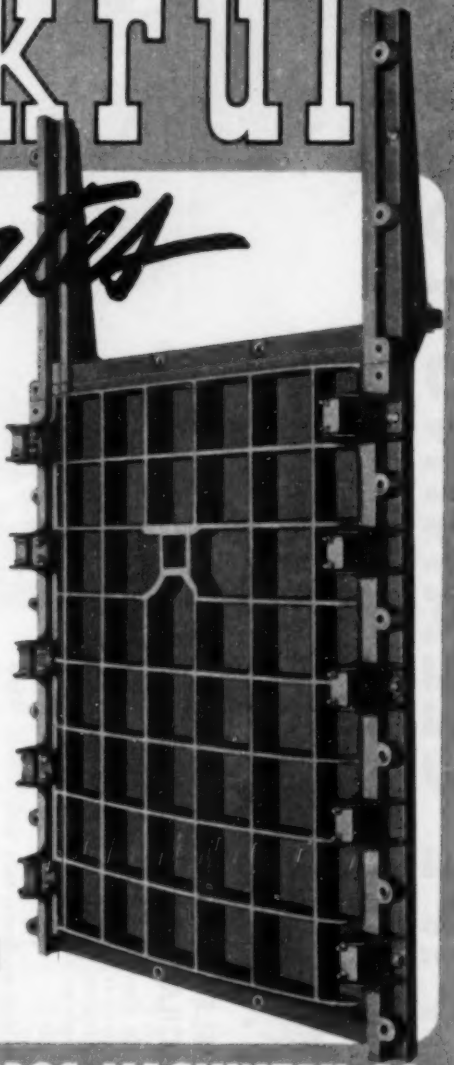

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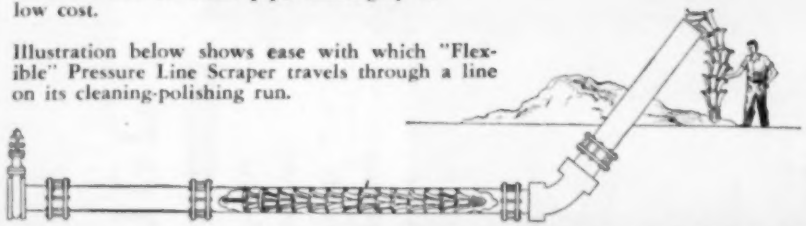

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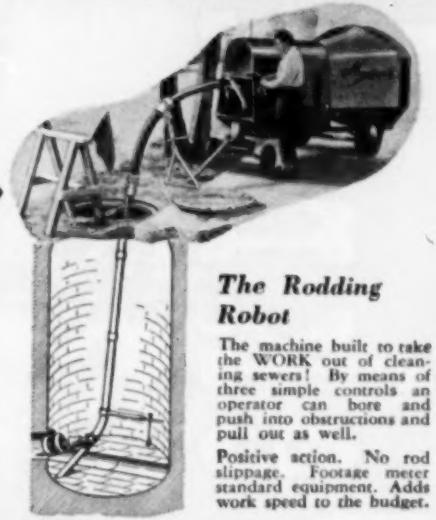

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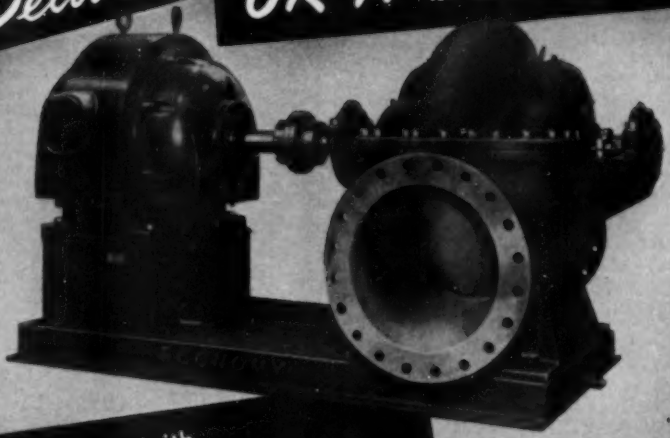

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(Continued from page 2)

Philadelphia water chief Elbert J. Taylor (left) showing Mayor Bernard Samuel 130-year-old iron globe valve that had been used when the city's water supply—now 150 years old—ran through wood mains.

piano-pounding impresariolation of Bill Orchard. A bow should be made to Larry Morgan's First-Timer's committee for making the convention tyros feel at home. And some measure of immortality ought to be bestowed upon the Yellow Cab Co., for providing drivers who gave us the scoop on the water front every day of the week.

Now with Philadelphia under our belts, we're already licking our lips for a taste of next April's Miami. Wild horses shouldn't keep you away.

(Continued on page 8)

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E-10

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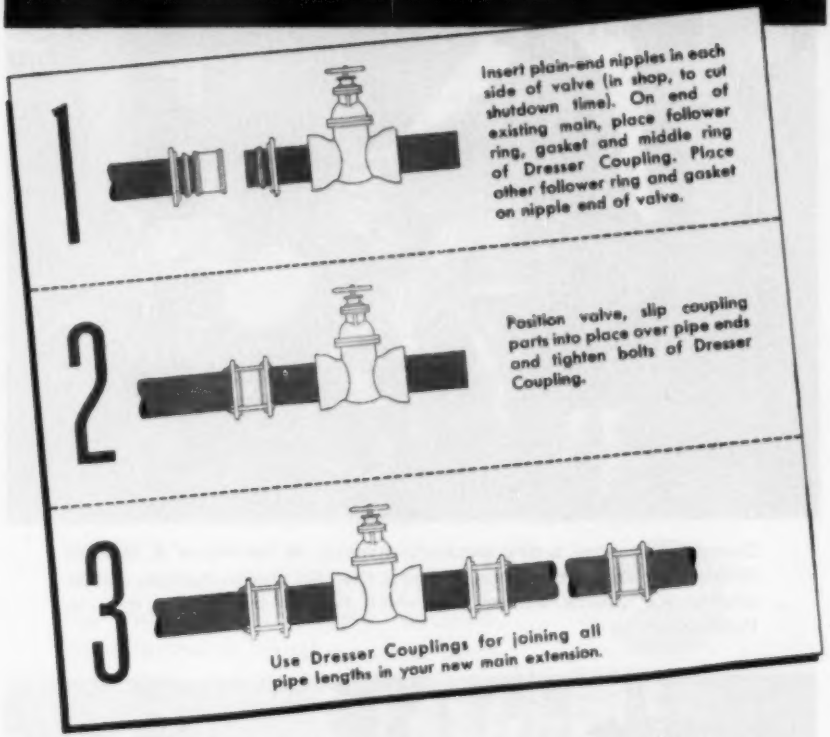
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Insert plain-end nipples in each side of valve (in shop, to cut shutdown time). On end of existing main, place follower ring, gasket and middle ring of Dresser Coupling. Place other follower ring and gasket on nipple end of valve.
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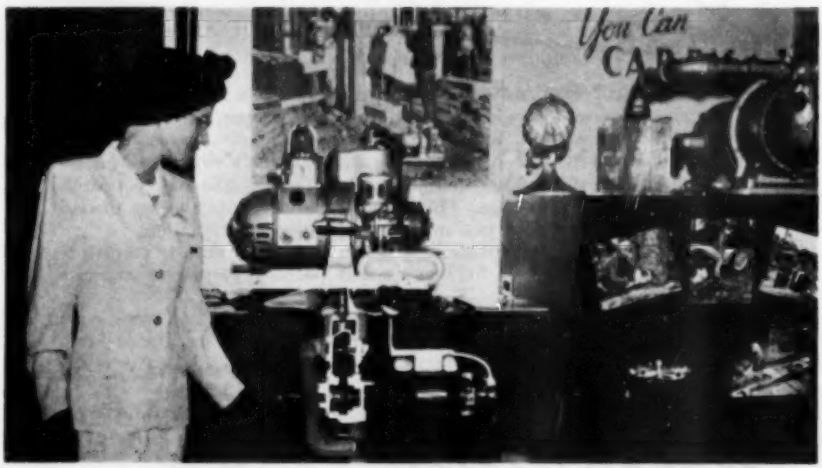
(Continued from page 6)

Dorothy Dimmers, acting secretary-manager of the Water & Sewage Works Manufacturers Assn., inspects the Old Oaken Bucket, shown gracing the famous well on the exhibit floor in between its trips to California.



Mrs. Helen Rotthaus stops at an exhibitor's booth to help exhibit. This was Ladies Day at the Philadelphia Conference.

(Continued on page 10)

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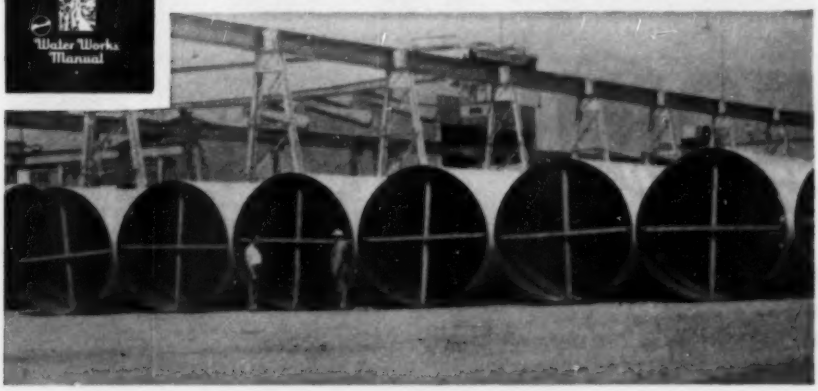

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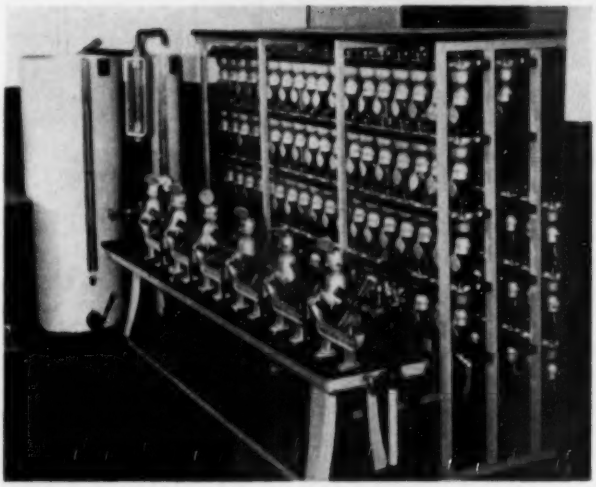
Annual Conference Prize-Winning Photos

BEFORE →

AFTER ↓



Renovation of the meter shop topped the entries in the operations class for Julius A. Nido, water superintendent for Waterbury, Conn. A safe bet is that the change-over paid off in more ways than just winning photography contests, too.

(Continued on page 12)

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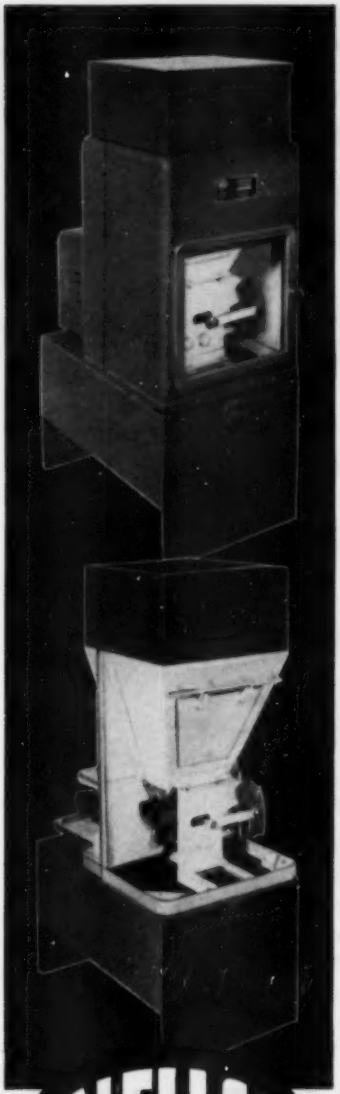

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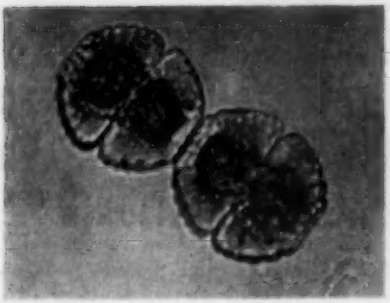
Annual Conference Prize-Winning Photos



Winner in the photomicrograph class was George Turre, sanitary engineer with the Denver, Colo., Board of Water Commissioners. The candid shots above are of *Cosmarium* (Chlorophyceae), shown dividing, and *Cyclops* (Crustacea).

M. J. Shelton, general manager and chief engineer of the La Mesa, Lemon Grove and Spring Valley Irrigation Dist., took first prize in the construction class with these action views of pipelaying in difficult terrain below Murray Dam, Calif.

(Continued on page 14)

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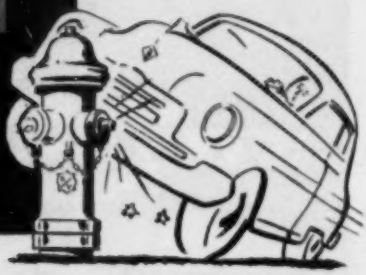

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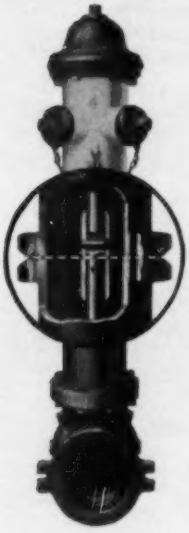

Wherever a fire hydrant faces the hazards of traffic . . . the community is safer, maintenance is lower, when it is a KENNEDY Safetop.

The whole secret is in the Safety Breakable Section (see enlarged inset on illustration). Notice the standpipe breaking ring. It has been so engineered that its strength is equal to that of the standpipe wall itself. This means that a KENNEDY Safetop Hydrant will stand up without breaking under any ordinary impact. But . . . the stresses are so distributed that when the breaking point is reached it breaks cleanly at the groove in the breaking ring.

The inexpensive stem coupling and breaking ring are the only parts to break . . . above ground where they are easily and quickly repaired. There's less damage to the car that hits it. Repair costs are a fraction of a below-ground break or of a fractured standpipe. The neighborhood does not risk curtailed fire protection for a protracted period.

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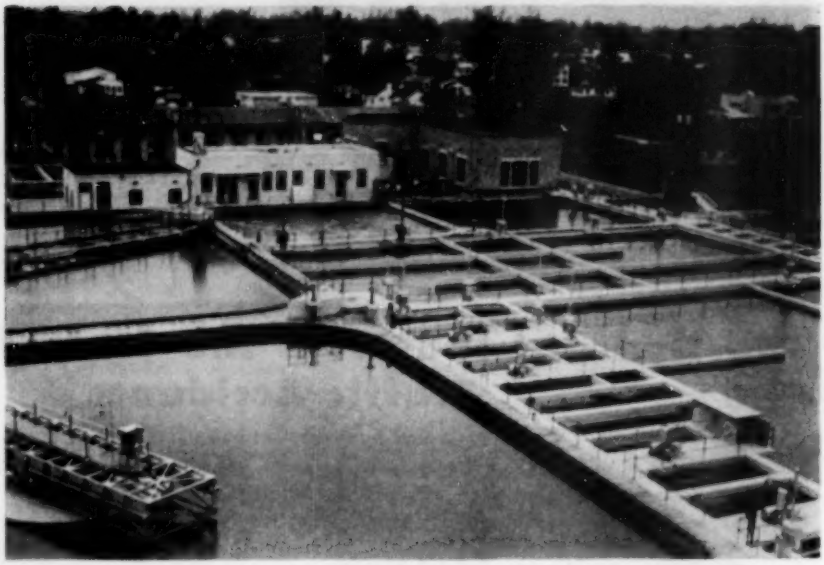
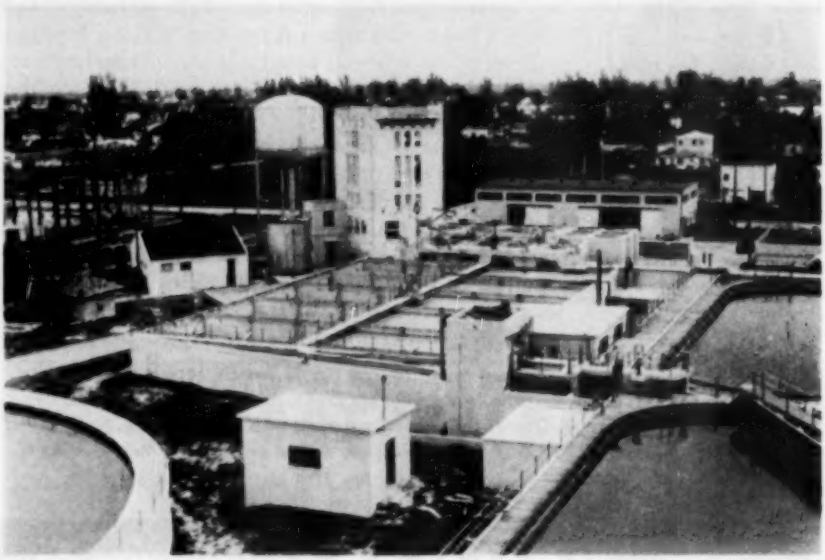
(Continued from page 12)

Annual Conference Prize-Winning Photos





Clarence Henry, chief chemist of the Dept. of Water & Sewers, Miami, Fla., garnered top honors in the general interest class with his aerial views of the Hialeah Water Plant.

(Continued on page 16)

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(Continued from page 14)

A. Clinton Decker, sanitary engineer with the Tennessee Coal, Iron and Railroad Co., Birmingham, Ala., died on May 22. He was 64 years old. Born at Prince Bay, N.Y., he received the C.E. degree from Cornell University in 1909, becoming chemist and bacteriologist for the East Jersey Water Co., Little Falls, N.J., the same year. After a brief interval in the same capacity with the Birmingham Water Works Co., he joined the Tennessee Coal, Iron and Railroad Co. in 1912 in the post he was to hold until his last illness interfered. From 1932 to 1939, he served on the engineering commission for the Birmingham industrial water supply, and since 1932 he had practiced as a consultant on water and sewage problems. Long active in technical associations, his A.W.W.A. accomplishments included the chairmanships of the Water Purification Div. and of the committee on the revision of the *Manual of Water Quality and Treatment,* and the award, in 1948, of the Diven Medal. He was also Director for the Alabama-Mississippi Section.

Oscar C. Blumberg, senior sanitary engineer with the California State Dept. of Public Health, died recently in Berkeley.

(Continued on page 18)

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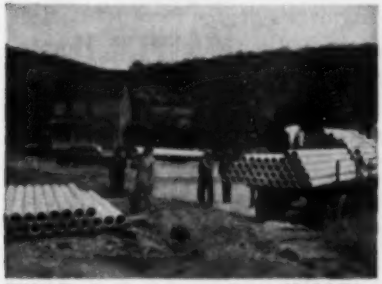

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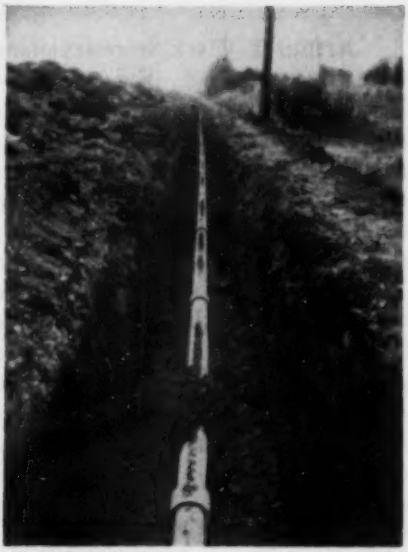

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(Continued from page 16)

Arthur T. Clark, secretary-manager of the Water and Sewage Works Manufacturers Assn., died in Morristown, N.J., on May 24, after a long illness. He was 65 years old. A familiar figure at A.W.W.A. conventions, even to those who did not know him personally, because of the distinctive light-colored hat he wore (he used to explain it made it easier for exhibitors in trouble to locate him), his passing occurred by a strange twist of fate while the Philadelphia Convention he could not attend was at its height.

Born in 1884, Clark obtained a civil engineer's degree from Rensselaer Polytechnic Institute in 1907. He was associated with Robert E. Horton, Albany, N.Y., consulting hydraulic engineer, for eight years; took charge of all utilities at Herkimer, N.Y., for ten; and over a similar period worked on water system design, construction and operation with the South Bay Consolidated Water Co. of Long Island, N.Y., the Community Water Service Co., and Morristown, N.J. In addition, he has been with Cluett Peabody & Co., the American Water Works Co., the Barrett Div., and Joseph G. Pollard Co. His association with the W&SWMA began in 1941, when he became manager of the headquarters office. He was appointed secretary-manager the following year.

(Continued on page 20)

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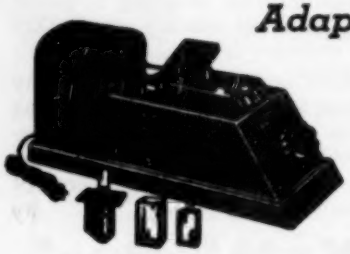

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(*Continued from page 18*)

A significant precedent was set when the Maryland Water Pollution Control Commission won its first court action to control stream pollution. The decision by Associate Judge John B. Gray of the 7th Judicial Circuit requires a sand and gravel company to correct processing operations which have been dumping approximately 8 tons per operating hour of mud, clay and fine sand into Indian Creek, a tributary of the Anacostia River. As the commission's first civil suit, the decision is considered doubly important, because it not only strengthens the commission's powers through establishment of precedent, but also reverses a setback experienced by the commission last year, when a criminal case in the appellate court against the same defendant was lost, the jury having reversed the judge's decision. Crux of the action was the commission's regulation that industrial wastes discharged to streams must not contain more than 400 ppm. of settleable solids.

Clyde Potts, civil and sanitary engineer, died on May 19 in Morristown, N.J., at the age of 73. In his extensive and vigorous career, beginning with his graduation from Cornell University in 1901, is reflected the history of the great advances in sanitary engineering made in the first half of this century. In addition to figuring in such significant lawsuits as those which established that the common septic tank did not completely dispose of all solids and was not patentable, and that the use of chloride of lime for the disinfection of water (as practiced at Jersey City, N.J.) provided a water legally acceptable as pure, he pioneered in sewage treatment developments and at one time worked with George W. Fuller. His influence in the development of additional supplies for New Jersey was characteristically strong, and he served as water adviser to the governor and campaigned strenuously for the provision of water supplies in anticipation of future demands. He was also a member of the State Dept. of Health for 25 years and its president for six terms, obtaining passage in 1918 of legislation licensing operators of water and sewage plants.

A native of Libertyville, Ind., Potts made Morristown his home after constructing its sewage system. Feeling that an overcautious water main extension program was hampering the growth of the town, he became active in politics, was elected mayor—a post he held for 24 years—and succeeding in having the community purchase and greatly enlarge the water system, with the result that the utility has an adequate supply for the future and also provides neighboring communities with water.

Juan A. Cosculluela, consulting engineer of Havana, Cuba, died in mid-May. A former member of the A.W.W.A. Board of Directors and recipient of his section's Fuller Award in 1947, he was also a founder member of the Cuban Section and its chairman in 1945.

(*Continued on page 66*)

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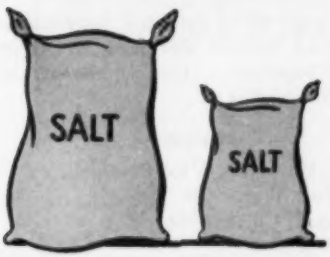

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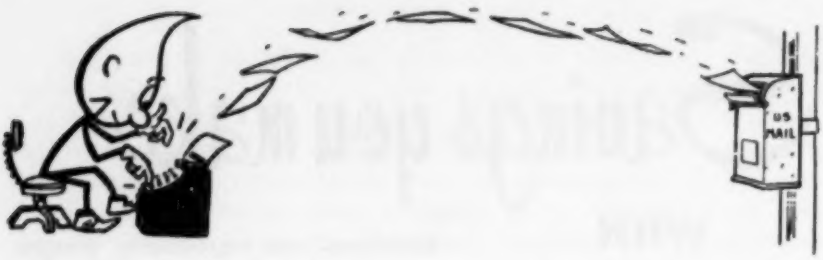

Waterborn

To the Editor:

I have been noting with interest the various letters under your correspondence column in the JOURNAL concerning father and son combinations in the American Water Works Association (April P&R, p. 22; May P&R, p. 42). While I cannot add to the list of members I thought that you might be interested in the fact that the Cedar Rapids, Iowa, Water Works is now being served by three generations of the Cherry family. Earl J. Cherry, our superintendent of the meter and service department, has been an employee since 1905. His son, Arnold Cherry, our plant chemist, has worked for the department since 1929. Arnold's son, Karoll, is now a part-time employee during summer months while going to college. This family combination is an unusual one and not found every day.

In addition, the Cedar Rapids water department has had several other family combinations among its employees. These include the three Diehl brothers—Amos, Carl and Donald—together with Carl's son George; and the following father and son combinations: Frank and Francis Pameticky, Fred S. and Fred J. Donisthorpe, George and Clifford Drummey, Mike and Charles Nunn, and George and Joe Getlin. Some of the above mentioned employees are no longer with the department, due to death or resignation, but in all cases the combinations all worked for the department at one time or another.

I may be wrong but I feel that this is something of a record as far as a water works of this size is concerned.

LEO LOUIS
Supt., City Water Works
Cedar Rapids, Iowa; June 13, 1950

To the Editor:

On page 80 of the May JOURNAL is a list of fathers and sons in water works together. Here is another to add to your list:

Father

Ralph H. Hyde, Vice-President
Campbell Water Co.
Campbell, Calif. (May '27)

Son

Homer H. Hyde, Secretary
Campbell Water Co.
Campbell, Calif. (July '48)

RALPH H. HYDE
Vice-President
Campbell Water Co.
Campbell, Calif.; June 10, 1950

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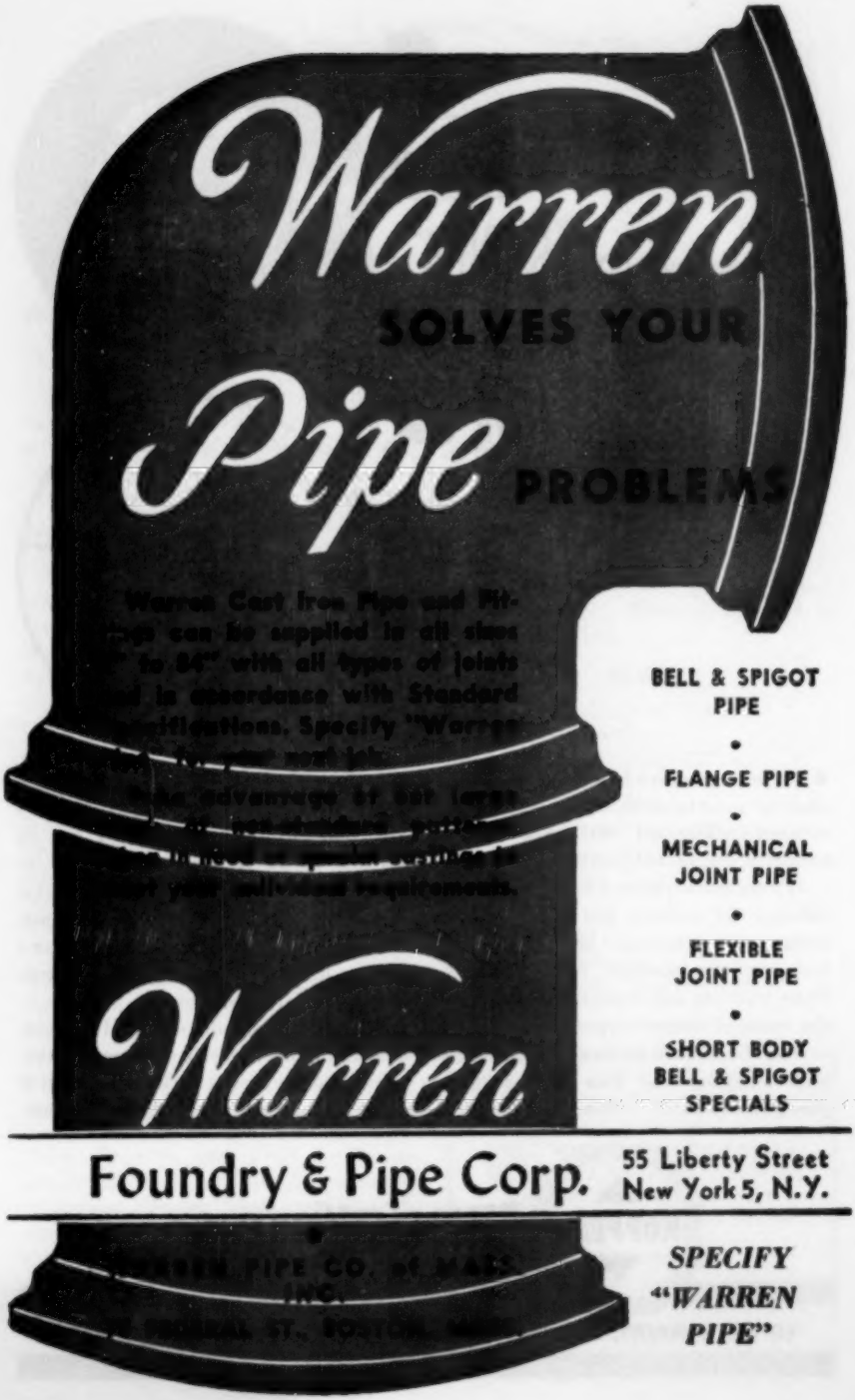
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Membership Changes

NEW MEMBERS

Applications received May 1 to 31, 1950

Bailey, Pierce, Jr. Engr., Div. of Water, Bureau of Eng., 565 N. Erie St., Toledo, Ohio (Apr. '50) *M*

Basalt Rock Co., Inc., Steel Products Div., H. H. Wilkins, 8th & River Sts., Napa, Calif. (Assoc. M. Jan. '50)

Belmont Smelting & Refining Works, Inc., George Henning, Pres., 330 Belmont Ave., Brooklyn 7, N.Y. (Assoc. M. Apr. '50)

Binford, R. W., *see* Burt & Binford

Bird & Tietzel, Cons. Engrs., Charles F. Bird, 2130 Arlington Ave., Columbus 12, Ohio (Corp. M. Apr. '50)

Bird, Charles F., *see* Bird & Tietzel

Bova, Anthony S., Owner, Soft Water Service Co., Erie, Pa. (Jr. M. Apr. '50) *P*

Brown, Max M., Filter Plant Foreman, Mountain States Power Co., Box 472, Albany, Ore. (Apr. '50) *P*

Burt & Binford, Contractors, R. W. Binford, Partner, 507 W. 2nd St., Hutchinson, Kan. (Assoc. M. Apr. '50)

Cantlupe, Victor J., Asst. Chief Engr., Pump Dept., De Laval Steam Turbine Co., Trenton, N.J. (Apr. '50) *M*

Carlton Water Dept., Clarke Morton, Water Supt., Carlton, Ore. (Corp. M. Apr. '50) *M*

Chemical & Geological Labs., James Gilmore Crawford, Pres., 521 S. Center St., Casper, Wyo. (Corp. M. Apr. '50) *P*

Cooperstown Board of Water Comrs., Newton E. D. Gilmore, Treas., Cooperstown, N.Y. (Munic. Sv. Sub. Apr. '50) *M*

Crawford, James Gilmore, *see* Chemical & Geological Labs.

Dizney, Robert E., Supt., Water Works, Box 77, Evarts, Ky. (Apr. '50)

Egolf, Joe L., Sales Repr., The Ludlow Valve Mfg. Co., 1636 Oliver Bldg., Pittsburgh 22, Pa. (Apr. '50)

Elbreder, Charles, Chemist, St. Louis County Water Co., 6600 Delmar Blvd., University City 5, Mo. (July '50)

Eschenbrenner, Irvin G., Chemist, St. Louis County Water Co., 6600 Delmar Blvd., University City 5, Mo. (July '50)

Ferringer, R. P., Jr., Filter Plant Supt., Brookville Borough Water Dept., Brookville, Pa. (Apr. '50) *MP*

Gartmann, Hans, Chief Engr., Pump & Compressor Dept., De Laval Steam Turbine Co., Trenton 2, N.J. (Apr. '50) *M*

Germany, Eugene Ben, Pres., Lone Star Steel Co., 4152 Mockingbird Lane, Dallas, Tex. (Apr. '50)

Getz, Carl W., Culligan Soft Water Service, Lansdale, Pa. (Apr. '50) *P*

Gilmore, Newton E. D., *see* Cooperstown Board of Water Comrs.

Gordon, Lloyd M., Pres., Gordon Bros., Inc., 8th & Ellsworth, Salem, Ohio (Apr. '50)

Hamilton, John J., 801 N.W. 103rd St., Miami, Fla. (Apr. '50)

Hammel, Lynd J., Civ. Engr., St. Louis County Water Co., 6600 Delmar Blvd., University City 5, Mo. (July '50)

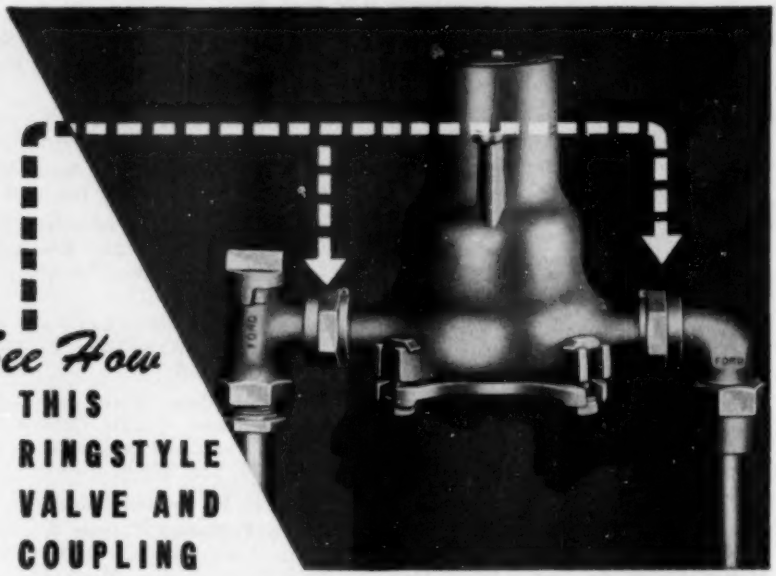
Harmeson, Donald K., Director, Div. of Sanitation, State Board of Health, Dover, Del. (Apr. '50) *MPR*

Harris, Elbert F., Cons. Engr., 720 Murray St., Alexandria, La. (Apr. '50) *MPR*

Harris, Jerome B., Supt., Water Works, Italy, Tex. (Apr. '50) *M*

Henning, George, *see* Belmont Smelting & Refining Works, Inc.

(*Continued on page 32*)



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(*Continued from page 30*)

Kelly, David C., Jr., Chemist, El Paso Natural Gas Co., Box 1492, El Paso, Tex. (Apr. '50) *P*

Kenney, Frank V., *see* White Rock Corp.

Kressler, Charles H., Chief, Valuation Dept., Gannett Fleming Corddry & Carpenter, Inc., 600 N. 2nd St., Harrisburg, Pa. (Apr. '50) *MPR*

Leiding, George A., Sales Engr., Hersey Mfg. Co., 582 Market St., San Francisco, Calif. (Apr. '50) *M*

Lenfestey, George S., Partner, Lenfestey Co., Box 3276, Tampa, Fla. (Apr. '50) *P*

Lyle, Sam H., Engr., St. Louis County Water Co., 6600 Delmar Blvd., University City 5, Mo. (July '50)

Maloy, L. E., Asst. Engr., Munic. Water Dept., 193 "D" St., San Bernardino, Calif. (Apr. '50)

McClain, William V., Mgr.-Partner, Culligan Soft Water Service, 530 "E" St., Brawley, Calif. (Apr. '50) *P*

Morton, Clarke, *see* Carlton Water Dept.

Mowry, Robert P., San. Engr., Town of Salem, Salem, Va. (Apr. '50) *P*

Nommensen, John D., Engr., St. Louis County Water Co., 6600 Delmar Blvd., University City 5, Mo. (July '50)

Osborne, Tracy R., Mgr., Softwater, Inc., 4105 N. 30th St., Omaha, Neb. (Apr. '50) *MP*

Peterson, Earl W., Sales Repr., Mueller Co., 3323 Aldrich Ave., N., Minneapolis, Minn. (Apr. '50)

Piette, Guillaume, Cons. Engr., 13, Place d'Aiguillon, Quebec City, Que. (Apr. '50) *PR*

Rady, Joe J., Cons. Engr., 811 Insurance Bldg., Fort Worth 2, Tex. (Apr. '50)

Roberts, Walter C., Director, Pacific Eng. Lab., 604 Mission St., San Francisco 5, Calif. (Apr. '50) *MP*

Roden, Carl Christian, Sales Engr., Builders-Pacific, Inc., 1036 University Ave., Berkeley 2, Calif. (Apr. '50) *P*

Rose, W. N., Town Clerk, Wallace, N.C. (Apr. '50) *MR*

St. John, Leigh E., Partner, St. John & Platt, Cons. Engrs., 504 Press Bldg., Binghamton, N.Y. (Apr. '50) *MPR*

Shields, Lewis S., Jr., San. Engr. I, State Board of Health, Bureau of San. Eng., Box 210, Jacksonville 1, Fla. (Apr. '50)

Smith, Robert E., Partner, Water Meter Repair Service, 114 E. 19th St., Kansas City, Mo. (Apr. '50)

Snyder, Reece C., Town Mgr., City Hall, Marion, N.C. (Apr. '50) *M*

Summers, Oliver W., Gen. Supt., Water Works Dept., Evansville, Ind. (Apr. '50)

Weber, George, Jr., Valuation Engr., Gannett Fleming Corddry & Carpenter, Inc., 600 N. 2nd St., Harrisburg, Pa. (Apr. '50) *MPR*

Whelchel, H. O., Jr., Chief Filter Plant Operator, City Water Dept., Covington, Ga. (July '50) *P*

White Rock Corp., Frank V. Kenney, Chief Chemist, Quality Control Lab., Foot of Van Dyke St., Brooklyn, N.Y. (Corp. M. Apr. '50) *P*

Wilkins, H. H., *see* Basalt Rock Co., Inc.

Worthen, F. Rishard, Partner, Worthen & Wing, Cons. Engrs., 11120 Gravelly Lake Drive, Tacoma, Wash. (Apr. '50) *MP*

REINSTATEMENTS

Fairbanks, Morse & Co., D. T. Johnstone, Mgr., Pump Div., 600 S. Michigan Ave., Chicago 5, Ill. (Assoc. M. Mar. '25)

Johnstone, D. T., *see* Fairbanks, Morse & Co.

Miller, Rube L., Northwest Mgr., Worthington-Gamon Meter Co., 2616 Western Ave., Seattle 1, Wash. (Apr. '44)

Norton, P. J., Clerk, Caledonia, Ont. (Apr. '48)

Reid, Joseph Y. L., Chief Chemist, Water Dept., Trenton, N.J. (Oct. '38)

Speir, William James, Idaho Water Works Corp., 1338 E. Center St., Pocatello, Idaho (Apr. '46)

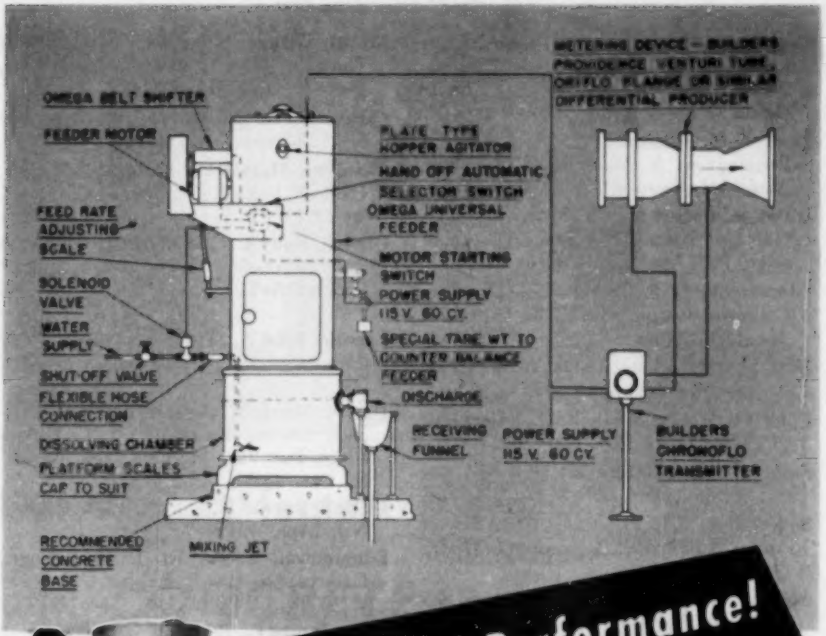
LOSSES

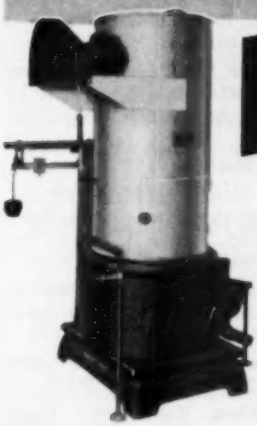
Deaths

Bready, Ira J., Dist. Mgr., Liquid Conditioning Corp., 3119 Griest, Cincinnati 8, Ohio (Jan. '38) *P*

Clark, Arthur T., Secy.-Mgr., Water & Sewage Works Manufacturers Assn., Inc., 170 Broadway, New York 7, N.Y. (May '19)

(*Continued on page 34*)





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(Continued from page 32)

Cosculluela, Juan A., Cons. Engr., Calle Linea No. 612, (Altos), Vedado, Havana, Cuba (Oct. '13) *Director '41. Fuller Award '47.*

Decker, A. Clinton, 1125 S. 22nd St., Birmingham 5, Ala. (June '14) *Diven Medal '48. Director '47–'50. P*

Gillespie, Robert N., Chief Engr., Cement Gun Co., Inc., 1520 Walnut St., Allentown, Pa. (Apr. '43)

Glassbrook, E. F., Mgr., Public Utilities California Corp., Niles, Calif. (Apr. '30) *M*

Hall, James C., Mgr., Public Works Com., Fayetteville, N.C. (Jan. '49)

Potts, Clyde, Civ. & San. Engr., 4 Farragut Pl., Morristown, N.J. (July '06)

Sargent, George Henry, City Engr., La Grange, Ga. (Dec. '29) *M*

Segerstrom, Eric J., Owner, DBA-Riverbank Water Co., Riverbank, Calif. (July '37)

Stewart, Charles M., 41 Congress St., Bradford, Pa. (July '35) *MPR*

Van Dyke, R. A., Sales Mgr., Northern Gravel Co., Box 307, Muscatine, Iowa (Oct. '44) *P*

CHANGES IN ADDRESS

Changes received between May 5 and June 5, 1950

Basich, George O., Repr., Rensselaer Valve Co., 4048 W. Taylor St., Chicago 24, Ill. (Oct. '49) *M*

Bassett, Kenneth M., Arizona Edison Co., Inc., Box 311, Phoenix, Ariz. (Oct. '49) *M*

Bates, Ralph D., Bureau of Environmental Sanitation, State Dept. of Health, State Office Bldg., Albany, N.Y. (Feb. '21) *P*

Beauchamp, Frank D., Pumphouse Operator, Fibreboard Products, Inc., 380 San Jose St., San Francisco, Calif. (Oct. '49) *MPR*

Benson, Curtis Carlyle, Waconia, Minn. (Jr. M. Jan. '50)

Berkowitz, Sidney A., Box 1871, Orlando, Fla. (Jan. '46) *P*

BeVier, Bradford V., 31 Sheffield Rd., Columbus 14, Ohio (Jan. '48)

Brown, George C., Chief Engr., City of Toronto, 32 Monarch Park Ave., Toronto, Ont. (July '41)

Carpenter, R. B., Jr., 211 W. Boscawen St., Winchester, Va. (Jan. '48)

Chandler, Harold C., 39 Noblock Court, Danker Village, Albany, N.Y. (Oct. '46) *P*

Cornell, Holly A., Cornell, Howland, Hayes & Merryfield, Cons. Engrs., 1600 Western Ave., Corvallis, Ore. (Apr. '49) *PR*

Corrick, John A., Texas Pool Corp., 2609 Cedar Springs, Dallas 4, Tex. (Oct. '49) *P*

Darby, Mitchell, Construction Co., Mitchell Darby, Pres., M. & J. Nelson Bldg., Box 369, McAllen, Tex. (Assoc. M. Oct. '48)

DeHoff, Ronald L., R.F.D. 1, Flemington, N.J. (Apr. '49) *P*

Edmundson, E. B., Jr., Utilities Engr., Goodyear Synthetic Rubber Corp., 214 W. B St., La Porte, Tex. (Jan. '46)

Egan, James F., 2611 Haynes, Fort Worth 3, Tex. (Jan. '46) *M*

Erganian, George, San. Engr., State Board of Health, Div. of San. Eng., 1330 W. Michigan St., Indianapolis, Ind. (Apr. '46) *MP*

Fooks, Jack Herbert, 117 Ohio Ave., Wilmington 171, Del. (Jan. '47) *R*

Gifford-Hill-American, Inc., Ray A. Foley, Pres., Box 4335, Station A, Dallas, Tex. (Assoc. M. Apr. '45)

Gillespie, Chester G., 641 N. 4th St., Banning, Calif. (June '11) *Fuller Award '47. P*

Gloyna, Earnest F., 112 E. Hunter Circle, Oak Ridge, Tenn. (Oct. '49) *MPR*

Granda y Deben, Robel, San. Engr., Public Health Service, Gomez 106 esquina a Santa Emilia, Santos Suarez, Havana, Cuba (July '38)

Grossman, Irving, 234 Charles Ave., Staten Island 2, N.Y. (Jr. M. Apr. '50) *PR*

Harbert, John M., III, Pres., Harbert Constr. Corp., Box 1369, Birmingham, Ala. (Oct. '49) *PR*

Hopkins, W. Howard, Gen. Mgr., Sanitation Dist. No. 1, 100 Chenoweth Lane, St. Matthews, Ky. (Jan. '40)

(Continued on page 36)

Concrete waterworks, Savannah, Ga., showing cast stone facing on front (left) and exposed masonry of rear (below). Sirene & Co., architects and engineers; the Virginia Engineering Co., contractor.

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(Continued from page 34)

Horstmann, F. B., Box 401, Venice, Fla. (June '27) *P*

Howard Supply Co., Rae R. Ellis, Mgr., Water Works Dept., Box 15344 Vernon Branch, Los Angeles 58, Calif. (Assoc. M. Oct. '43)

Jones, Paul M., Civ. & Mining Engr., 20 Bishop Ave., Madisonville, Ky. (Jan. '49)

King, George M., Munic. Engr. & Land Surveyor, 223 Irving Ave., Bridgeton, N.J. (Oct. '41) *P*

Kline, Harry F., Jr., Chief Operator, Pinellas County Water System, 811—10th St., S.W., Largo, Fla. (July '48)

Laubach, Walter J., Chief Operator, Water Dept., Lincoln Way, W., R.D. 5, Wooster, Ohio (Jan. '48) *P*

Mathews, Everett R., Chief San. Chemist, Zia Corp., 2137C—43rd St., Los Alamos, N.M. (May '34) *P*

McKee, Donald M., The Permutit Co., c/o Hotel Keenan, Fort Wayne, Ind. (Jr. M. Jan. '48)

Metz, Don T., Branch Mgr., Byron Jackson Co., 216 Pine St., San Francisco 4, Calif. (Jan. '46) *M*

Moore, Carl C., Dist. Mgr., Pittsburgh Equitable Meter Div., Rockwell Mfg. Co., 43 W. Long St., Columbus, Ohio (Apr. '39)

Moore, Robert E., Chief Operator, Canadian Celanese, Ltd., 777 A Mercure, Drummondville, Que. (Jan. '50)

Odgen, William H., 513 Clarks Ave., Clarks Summit, Pa. (July '35) *M*

Peart, Robert F., City Mgr., Box 694, Garden City, Kan. (Apr. '49)

Ponder, Ottie Carrell, Water & Sewer Supt., Jefferson County Water Control & Improvement Dist. No. 1, Box 846, Groves, Tex. (Oct. '44) *MP*

Pullen, P. T., Viking Supply Corp., Shreveport, La. (Oct. '45)

Raleigh Water Dept., E. M. Johnson, Director, Public Utilities, Filter Plant, Raleigh, N.C. (Corp. M. Oct. '40) *MP*

Randlett, Fred Morse, Cosmopolitan Club, 614 S.W. 11th Ave., Portland, Ore. (June '20) *Trustee '25–'27.*

Randolph, M. L., 2839 A Puuhonua St., Honolulu 14, Hawaii (July '48)

Redmond, John, Jr., Capt., Surgeon's Office, Headquarters 2nd Army, Ft. George G. Meade, Md. (Oct. '46)

Richards, Kenneth G., Councilman, Water Dept., Box 237, Eveleth, Minn. (Jan. '46) .

Russell, J. Bernard, 812 N. Sycamore St., Creston, Iowa (Jan. '42) *M*

Ryle, John, Supt., Passaic Dist., Passaic Valley Water Com., 1535 Main Ave., Box 203, Clifton, N.J. (Dec. '19) *M*

Scharff, Maurice R., Cons. Engr., 366 Madison Ave., New York 17, N.Y. (Jan. '26) *M*

Senges, Donald C., 43 New Ardmore Ave., Broomall, Pa. (Jan. '39) *P*

Shultz, Clifton S., Supt., Water Dept., 557 N. Main St., Sebastopol, Calif. (Apr. '47) *M*

Smedberg, C. W., Box 8896, Richmond 25, Va. (Dec. '22) *Director '31–'34. MP*

Stone, J. W. L., Dist. Mgr., Peerless Pump Div., Box 1198, Omaha 1, Neb. (Jan. '49)

Sudhoff, Robert R., San. Engr., Box 491-A, R.R. 3, Jeffersonville, Ind. (Jan. '43) *MP*

Sweitzer, Robert J., 811-B Cedar Lane, Riverton, N.J. (Jan. '46) *PR*

Tanner, William S., 2601 Danube Drive, Sacramento 15, Calif. (Jan. '45) *MPR*

Tetzlaff, Frank, 247 Piermont Ave., Nyack 6, N.Y. (Jan. '36) *P*

Thompson, Ralph F., Box 705, College Station, Tex. (Jan. '48) *PR*

Travaini, Dario, City Engrs. Office, 837 E. Jefferson St., Phoenix, Ariz. (July '40) *P*

Vetromile, Daniel S., Sales Engr., 1153—84th St., Brooklyn 28, N.Y. (Oct. '49)

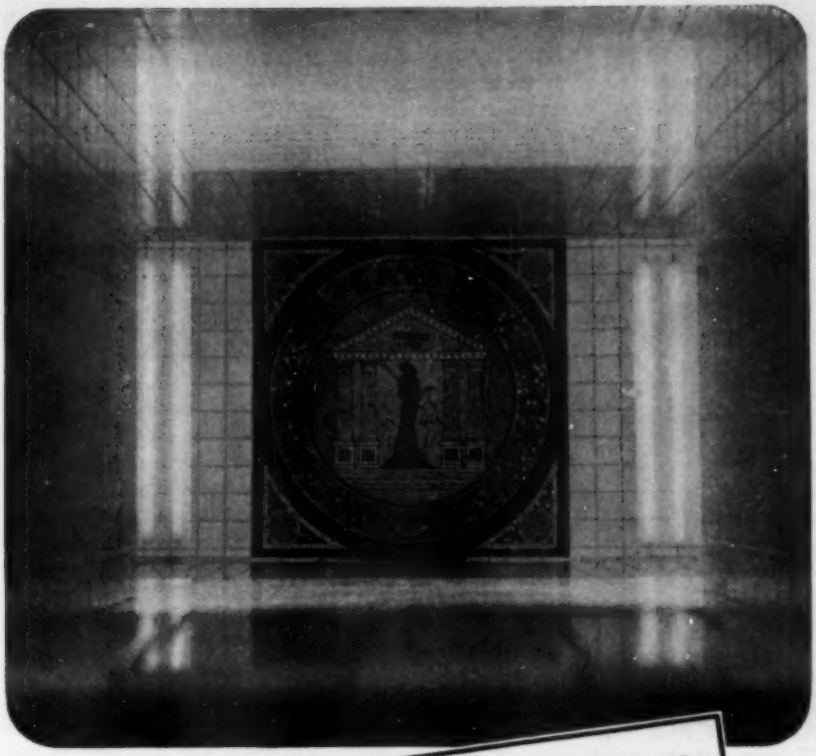
Williams, Johnie E., Water Supt., City Hall, San Angelo, Tex. (Apr. '47)

Williams-Smith, Francis Thomas, c/o Mr. A. E. Fordham, Gen. Mgr. & Secy., Water Dept., County of Birmingham, England (Jan. '48) *M*

Willian, Robert T., Mgr., Sunny Hollow Water Dist., 78 E. 32nd St., Eugene, Ore. (Jan. '48)

Wright, John D., 1312 Park Bldg., Pittsburgh 22, Pa. (Jan. '49)

Zapffe, Carl, 325 Bluff Ave., Brainerd, Minn. (July '35) *P*



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ROBERTS FILTER MANUFACTURING CO.
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Condensation

Key: In the reference to the publication in which the abstracted article appears, **39**:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is paged by the issue, **39**:5:1 (May '47) indicates volume 39, number 5, page 1, issued dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *B.H.—Bulletin of Hygiene (Great Britain); C.A.—Chemical Abstracts; I.M.—Institute of Metals (Great Britain); P.H.E.A.—Public Health Engineering Abstracts; S.I.W.—Sewage and Industrial Wastes; W.P.R.—Water Pollution Research (Great Britain).*

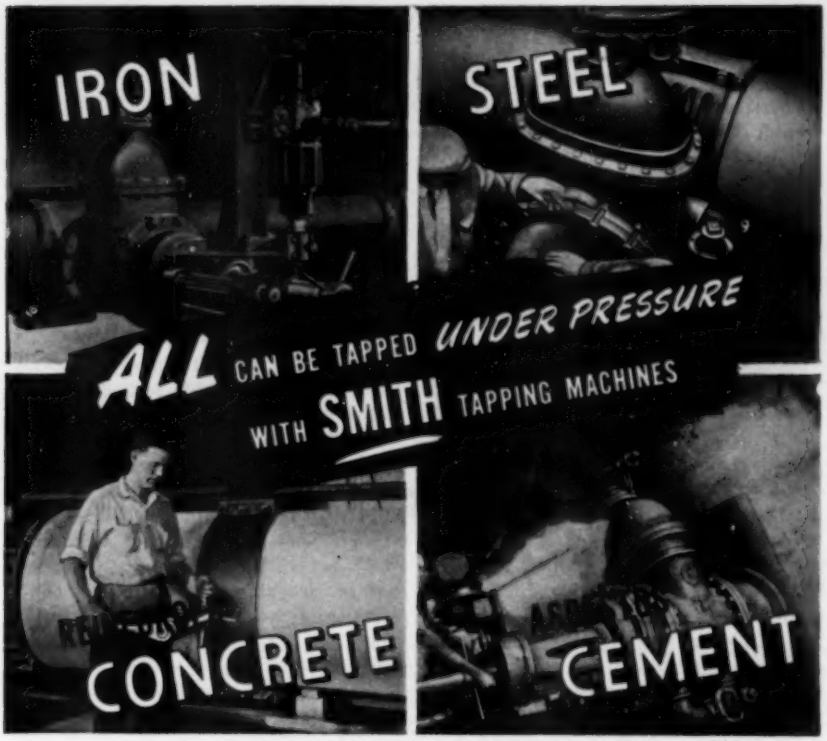
HEALTH AND HYGIENE

Cyanosis of Infants Produced by High Nitrate Concentration in Rural Waters of Saskatchewan. H. E. Robertson & W. A. Riddell. Can. Pub. Health J., **41**:2:72 (Feb. '49). Further evidence presented of possible dangers to infants from nitrates in water used for making up artificial feeds. More than 2000 samples of rural drinking waters examd. for nitrates. Almost ¼ of these well waters contained more than 10 ppm. nitrate, which is regarded as potentially dangerous. In about 5% of waters, concn. of nitrate over 300 ppm. Ten cases of methemoglobinemia in infants, all of whom had had artificial feeds made with water contg. at least 75 ppm. nitrate, mentioned. Two of these fatal. In both, water used contained over 1200 ppm. nitrate. Autopsy found that 25 and 44% respectively of hemoglobin had been converted to methemoglobin. Pointed out that occurrence of methemoglobinemia depends not only on nitrate in water but also on condition of infant. Authors quote Cornblath and Hartman (*J. Pediatrics*, 1948, **33**:421) who state that only infants who have gastric pH higher than 4.0 and nitrate-reducing bacteria in upper gastrointestinal tract ever develop methemoglobinemia from oral ingestion of waters contg. nitrates. Value of intravenous methylene blue in treatment of severe cases mentioned.—*B.H.*

Toxic Level of Fluorine in Water Supplies. D. C. Badger. Am. J. Diseases Children, **78**:1:72 (July '49). Author in practice in area of New Mexico where public water supply contains about 0.9 ppm. of fluorine. He examd. 90 children who had spent whole of their lives in area, and found enamel defects in 28 of them. Defects were not severe, and in no case was there brown pigmentation of mottled enamel patches. Author suggests possibility of fluoride-contg. fruit sprays having been factor in production of so much dental fluorosis, but apparently regards water supply as having been mainly responsible. Since artificial fluoridation of water usually aims at producing concn. of 1 ppm. of fluorine, author feels that widespread use of fluoridated water is faulty procedure and will lead to unhappy results. Recommends that, if fluoridation carried out, concn. of 0.7 ppm. of fluorine should not be exceeded. [Author mentions that climate in area hot and dry, and, therefore, amt. of water drunk may be high. Obviously amt. of fluorine ingested in water depends, not only on concn. in drinking water, but also on amt. of water drunk. It may be that 0.9 ppm. is an undesirably high level in New Mexico, but does not follow that 0.7 ppm. is safe upper limit in all other areas.]—*B.H.*

Dental Effects of Exposure to Fluoride-Bearing Dakota Sandstone Waters at Various Ages and for Various Lengths of Time. I. Status of the Permanent Teeth of 339 Children Aged 11 to 15 Years Who Used

(*Continued on page 40*)



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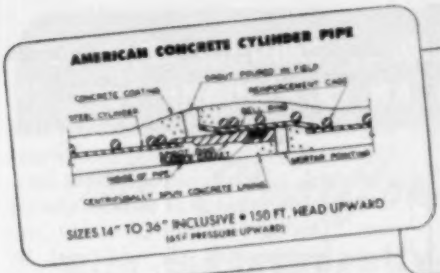
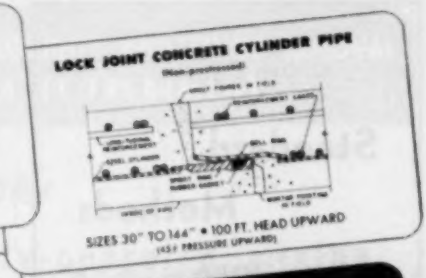
(*Continued from page 38*)

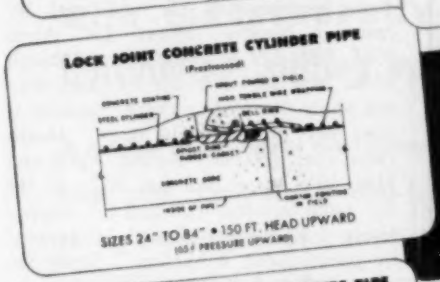
Such Water for Eighteen Months Prior to Eruption of the First Permanent Molars. A. L. RUSSELL. J. Dental Research, **28**:3:298 (June '49). For some years prior to Aug. '35 town of Mitchell, S.D., obtained water supply from lake. Supply contained only 0.2 ppm. of fluorine. Owing to drought it became necessary to supplement lake water with water from 2 artesian wells—latter supply having fluorine content of 2.8 ppm. For first 4 months proportions were about ⅓ well water to ⅔ lake water. In next 2 months well water used exclusively, while for next 4 months only lake water used. During next 5 months there was again mixt. similar to that used in first 4, and this was succeeded by 3 months' supply of well water exclusively. Estd. that mean fluorine content of town's supply during 18 months in neighborhood of 1.15 ppm. In '47–'48 author made detailed record of dental condition of children who had been thus exposed to fluorine prior to eruption of their first permanent molars. Author compared his findings with those for children of similar age groups in Sioux Falls, S.D., and Hagerstown, Md. Could find no evidence whatever of inhibition of caries in Mitchell children. Author's view is that these findings tend to weaken hypothesis that mechanism whereby dental caries inhibited through exposure to fluoride-bearing drinking waters depends essentially upon deposition of fluorine in dental enamel during period of calcification. [Possible that author's results would have been different if Mitchell water had consistently contained 1.15 ppm. of fluorine instead of fluctuating as it did. Supply which consistently contained over 1 ppm. of fluorine would be expected to produce considerably more mottling than was found in Mitchell children. Those who were 11–15 years of age when examd. showed mottling in barely 8% of cases.]—*B.H.*

The Control of Water and Food Supplies on Air Routes. H. WHITTINGHAM. Pub. Health (Gt. Br.), **62**:11:223 (Aug. '49). Safe water and food supplies along air routes essential not only to preserve health of crew and passengers but to prevent spread of waterborne or foodborne disease. Considerable attention given, therefore, to design and construction of water points and portable water tanks to supply water to aircraft at airports, as well as of tanks and flasks used as containers in aircraft. To prevent food infections, plans made to supply all routes with precooked, deep-frozen foods, which have been carefully prepd. and hygienically packed before freezing. Meta-filters being installed at water points to deliver 500 gph. and 25–40-gal. water tanks of std. design mounted on trolleys. Tanks cleaned and sterilized with chlorine at least twice weekly. Stainless steel best for water tanks in aircraft, disinfected with chlorine at end of each flight. In addn. they are thoroughly cleansed after every 400 hr. of flying time. Aircraft tanks filled with water directly from airport tank, which, at most airports, must be chlorinated for at least ½ hr. before pumped into airplane tank. Vacuum flasks used to keep water cool for drinks, or to keep other fluids, such as coffee, hot. Strict attention paid to sterilization of all flasks at each airport as they are very difficult to keep sterile. Hosepipe to deliver water to aircraft usually made of tasteless rubber, but recent tests have shown that certain plastic piping does not impart taste to water and is easier to keep clean from bact. point of view. All water drawn from tanks during flight either boiled or chloraminated by galley steward.—*B.H.*

(*Continued on page 42*)







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(Continued from page 40)

Renewed Outbreak of Endemic Typhoid in France. P. CHASSAGNE. L'Eau (Fr.), **36**:119 (July '49). After war, epidemics decreased, but during last 2 yr. typhoid fever outbreaks increased. Death rate reached max. in Sept. '48, equivalent to max. during war. During first months of '49, epidemic accentuated, as indicated by cases in Vendée: March 256, April 1045, May 329, total 1695 from March 10 to June 10. Number of cases does not show complete picture, because it does not include mild ones. Death rates (per 100,000) during April and May 1948 were 20.2 and 30.7; in '49 for same months, 62.8 and 72, respectively. Epidemics caused in general by paratyphoid B bacillus. Study indicates that during past several years most of 7000 typhoid fever cases due to polluted water.—*Willem Rudolfs*

The Design and Selection of Sanitary Fittings. A. F. B. NALL. J. Roy. San. Inst. (Gt. Br.), **69**:2:101 (Mar. '49). Paper traces historical development of sanitary fittings, considers physical attributes of their materials and examines methods of construction. Materials should be durable, impervious, noncorrodible and have smooth surface which is easily cleaned. Ceramic group, which includes earthenware, fireclay, stoneware and vitreous china, has been chief source for most sanitary fittings. Vitreous-enameled cast iron and enameled steel also used for wide range of fittings, and stainless steel, Monel metal and aluminum alloys popular in construction of sinks and lavatory basins. Plastics lately used for some fittings. Vitreous china only material which is vitrified throughout, and this is impo.tant factor in hygiene, since if surface glaze removed it remains impermeable. Its use so far restricted to smaller fittings due to difficulty of preventing warp-

(Continued on page 44)

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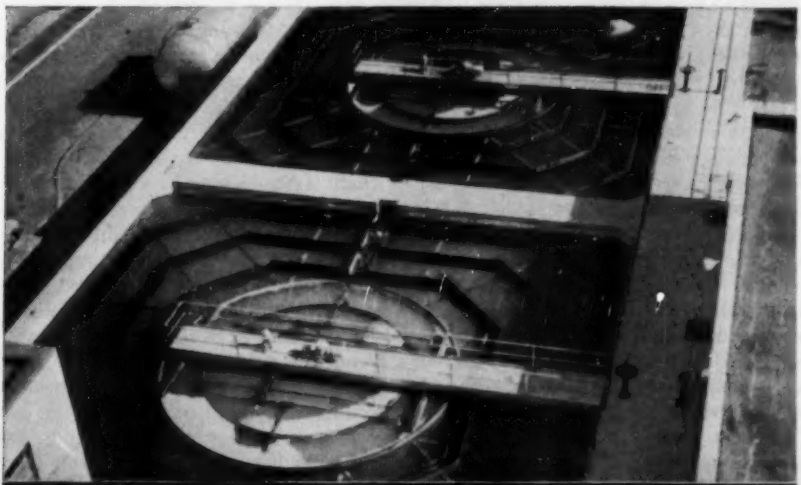

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(*Continued from page 42*)

ing in larger units such as urinals. Aluminum would seem to have particular place among metals since it can be supplied in self-finish enameled or anodized forms. Old prejudice against aluminum in connection with food now overcome, but dark stain which so often appears on aluminum fittings disadvantage. Value of plastics yet to be detd. Although colors and design often attractive, some plastics more affected by thermal changes than others and in fittings such as lavatory basins thermal stability essential. *Technical aspects of construction:* Basic requirements—[1] should be no pockets to collect dirt or other matter; [2] drainage should be rapid and complete and possibilities of blockage should be as slight as practicable; [3] working parts should be reliable, efficient and designed to operate with min. of attention; [4] arrangements for connection to water supply and drainage system should facilitate leakproof joints and admit of ready disconnection; [5] convenience of user should be met so far as practicable and consonant with 1–4 above. Postwar Building Studies No. 4 ('44), on plumbing, listed most commonly occurring defects of sanitary fittings as follows: [1] inefficient flushing of closets; [2] badly designed or maintd. drawoff taps or ball valves; [3] flushing cisterns operating noisily on acct. of inferior design and finish; [4] tap washers of inferior qual. and unsuitable material; [5] early deterioration of closet seat hinges and buffers; [6] screw caps under traps of wash basins and sinks which cease to be watertight after a few removals; [7] early deterioration of glazed finish on appliances. This list does not support view that design or construction based on wrong principles, but rather that defects arise from deviation from approved and established practice. *Lavatory basins:* Present trend undoubtedly toward larger basins, thus facilitating rounding of angles and making cleansing easier. Suggested that tendency should be to encourage shapes free from complicated outlines. Advantages of having combination taps questionable. Modern basin fills so rapidly that there seems little advantage in blending hot and cold water. *Baths:* Present tendency toward paneled bath should be encouraged. It is more pleasing in appearance and, although means sealed void inaccessible for cleansing, unpaneled bath also difficult to clean underneath and more likely to collect dirt. *Shower baths:* Shower baths provide most hygienic method of bathing and need not be wasteful of water. Difficulties generally lack of accommodation and wide difference in water supply pressures. Simplest soln. to latter is to plan installation so that pressures approximately equal. *Sinks:* Sink probably most important and certainly most used sanitary appliance in house. Modern trend is for combined sink and draining board. Detached draining board generally insanitary fitting as junction between sink and board collects dirt and difficult to clean. Advent of metal sink has led to development of kitchen unit in which sink, draining board and cupboards incorporated in piece of furniture. Such units excellent sanitary fittings, but unfortunately some made of too light metal to stand heavy wear to which kitchen furniture of necessity subjected. *Water closets:* Present trend toward low-level cisterns, and one-piece pan and cistern has been introduced. Height of water closets has long been matter of controversy, but there has been general reduction from customary 16–17″ to about 12–14″. *Flushing cisterns:* These have been subjected to much criticism, but only alternative is flushing valve which does not commend itself to water au-

(*Continued on page 46*)

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(*Continued from page 44*)

thorities. Low-level cistern to be welcomed. Most cisterns supplied from main and this is to be regretted since it places heavy strain on ball valve and brings water into closer contact with soil fitting than necessary.—*B.H.*

Industrial Safety at Water Works. Wacław Popielski. Gaz, Woda i Tech. Sanit. (Poland), **23**:262 (July–Aug. '49). Various industrial safety practices described, including: guards on all moving equip., grounding of all elec. equip., reduction of voltage on portable lights to be used in wet areas from 220 to 24 v. through use of "safety transformers," covering of all openings with substantial decking, catwalks over oily floors, screening of lathes and grinders and use of safety glasses, proper use of tools, use of eye shields in welding, adequate storage of gas bottles, precautions to be observed in working in shafts which may contain gases (one man in shaft with safety belt attached to ropes held by associates at ground surface), shoring of trenches, protection from static electricity and stray currents, and use of auxiliary equip. such as batteries in power failures.—*Conrad P. Straub.*

Protecting the Health of Tunnel Workers. A. E. Goss. Indus. Hyg. Newsletter, **9**:4:10 (Apr. '49). Excavation of twin-bore tunnel about 1200′ long, each bore 28′ wide and 18½′ high, completed, near New York. Measures described for control of 2 potential hazards to health—dust from drilling rock and exhaust gases from power equip. Rock basically igneous with free-silica content of less than 5%. Drilling was done wet and concn. of rock dust disseminated in tunnels well below limit for safe working conditions. Drilling done from 2 movable stagings and air compressors located outside tunnels. Powered units used in tunnels included shovel, 2 bulldozers

(*Continued on page 48*)

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and 3 dump trucks, all with diesel engines; at no time were more than 3 of these units likely to be in operation in bore at once. Advantage of diesel engine over gas engine for underground work is low concn. of CO in exhaust gas, provided fuel-air ratio kept below 0.068 lb. of fuel per lb. of air; usually operated with full load on fuel-air ratio of 0.055 lb., when CO in undiluted gases usually less than 0.25% by vol. Chem. anals. of exhaust gases from diesel equip. showed that CO was 0.015% from 3 engines, and 0.020, 0.030 and 0.40%, respectively, from others. Other exhaust gases included oxides of nitrogen found to give concn. of 30–40 ppm. Two electrically driven centrifugal fans supplied air to each tunnel, with addnl. fan which could be used for supplying or removing air. This equip. placed 60′ outside entrance to each tunnel, and air carried by suspended ducts to about 135′ from face of bore. Each fan delivered about 10,000 cfm. of air. Smoke from blasting took about 30 min. to clear, and permission to enter bore not given until clear condition evident.—*B.H.*

BACTERIOLOGY

The Effect of Temperature Upon Bacteriostasis. W. P. VAN ESELTINE & O. RAHN. J. Bact., 57:5:547 (May '49). In these investigations concd. nutrient broth dild. with water and antiseptic soln. to yield succession of tubes contg. same amt. of food but different doses of bacteriostatic agent. Each tube inoculated with one loopful of 24-hr. culture of test organism and tubes incubated at various temps. All tubes observed frequently during 1 mo. and time when turbidity began recorded. Organisms used were *Esch. coli, Staph. aureus* and *Ps. pyocyanea.* Shown that gentian violet had much greater bacteriostatic action at 15°C. than at higher temps. against all 3 organisms. Phenol, on other hand, least efficient at 30°C., but when temp. raised to 37° and 40°C. or lowered to 15° and 20°C., it had stronger antibact. action. Mercuric chloride, quaternary ammonium compd. and sulfanilamide showed temp. effects similar to those seen with phenol. Results obtained with sodium azide and crystal violet similar to those occurring with gentian violet. In discussion authors suggest that sodium azide and gentian violet act by changing oxidation-reduction potential of medium to unfavorable Eh. Increasing temps. do not greatly change potential but increase metabolism, thus favoring adjustment of potential by multiplying bacteria. Therefore, at higher temps. organisms become less sensitive to action of these agents. With most other antiseptics max. tolerance observed at 7°–10°C. below optimal temp. for growth. Suggested that this is because temp. increases both growth rate and rate of reaction of antiseptic with cell contents. Difference between these 2 effects dets. growth rate in presence of disinfectant.—*B.H.*

The Bacteriological Aspects of Deionized Water. PHILIP C. EISMAN, F. C. KULL & R. L. MAYER. J. Am. Pharm. Assoc., 38:88 ('49). Bact. content of deionized H_2O bears no relation to its chem. purity. Immediately after regeneration of ion exchanger deionized H_2O sterile or nearly so; its bact. concn. thereafter depends on frequency of use and regeneration of columns.—*C.A.*

The Membrane Filter in Water Bacteriology. H. KRUSE. Gesundh.-Ing. (Ger.), 70:9/10:154 (May '49). Description, probably intended for water engineers, of app. for estg. content of coliform bacteria in water. Consists of large funnel capable of

(*Continued on page 50*)

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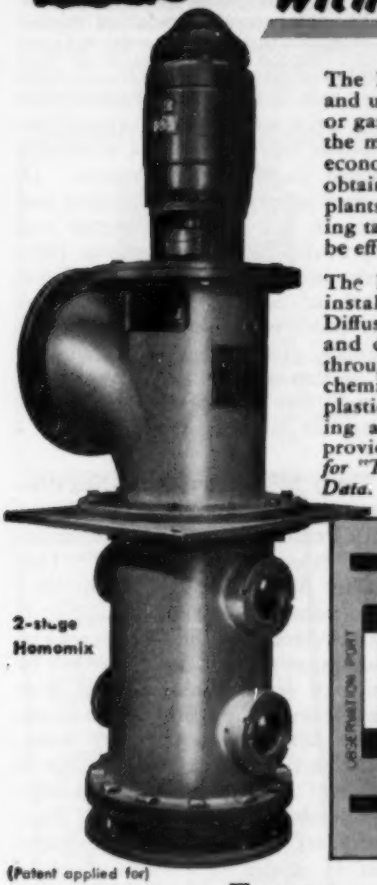

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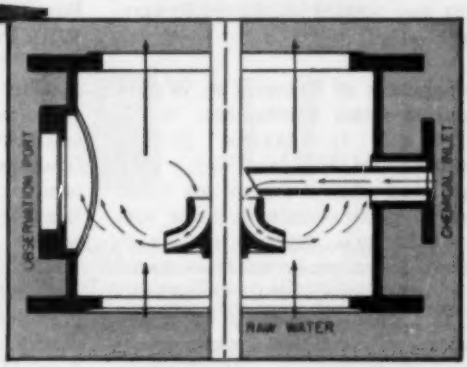

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(*Continued from page 48*)

holding up to 200 ml. of water mounted over collodion filter membrane through which water can be drawn. Membrane then placed with sterile forceps on surface of plate of Endo medium which is incubated at 37°C. Nutrients diffuse through membrane, and colonies of *Esch. coli* developing on its surface can be counted and picked for further tests. Author states that method has given reliable results in over 1000 tests at his institute. Also discusses possible value of app. in isolation of typhoid or paratyphoid bacilli, with use of some selective medium such as that of Wilson and Blair.—*B.H.*

Importance of the Isolation of Bacteriophage in the Estimation of the Sanitary Quality of Water. A. GUELIN. Rec. Trav. Inst. Nat. Hyg. (Fr.), **1**:158 ('47). Estns. made over period of year of quant. of bacteriophage in sewage and Seine R. water. Phages specific to *Esch. coli* and to 2 strains of *Salm. typhi* were studied and at same time *Esch. coli* content of samples estd. Found that there was positive relationship between coliform counts and content of related bacteriophage.—*B.H.*

Development of Bacteria in Waters Stored in Glass Containers. C. B. TAYLOR & V. G. COLLINS. J. Gen. Microbiol., **3**:1:32 (Jan. '49). Well known that when fresh or sea water stored in glass containers, some species of bacteria multiply rapidly to numbers far in excess of those found under natural conditions. Growth occurs at 2 sites—in body of water and at surface of container, constituents of which affect process. Hard glass, such as pyrex and fused silica, inactive, but soft glass, such as Bohemian, stimulatory. Relationship existed between size of container and degree of bact. multiplication; thus increase in count per unit vol. which occurred when bottles vigorously shaken was greater in small bottles than in large, due to removal of cells attached to walls. Greater surface area in relation to vol. means greater increase in bact. count. Low storage temps. repress multiplication, whereas raised temps., in region of 20°C., usually increase rate of multiplication. Water stored in container is under unnatural conditions; natural circulation ceases, particulate matter settles to bottom, plankton dies (particularly if container kept in dark) and there is relatively large solid surface exposed for periphytic types of bacteria to become attached to walls of container. In presence of phosphorus, nitrogen and carbon as sol. inorganic matter and as provided by dead plankton cells, water becomes dilute medium for growth of certain types of bacteria. Only small proportion of bact. types originally present capable of multiplying, so that dead cells of types unable to grow may provide further nutrient matter for surviving types.—*B.H.*

In Vitro Effects on Gram-Negative Bacteria of Streptomycin Combined With Penicillin and/or Sulfadiazine. E. J. PULASKI & H. J. BAKER. J. Lab. & Clin. Med., **34**:2:186 (Feb. '49). Bacteriostatic effect of penicillin *G* and streptomycin on 9 genera of Gram-negative organisms studied by means of serial dilns. in broth with large inoculum of growing cultures, results being read after 40 hours. Penicillin *G* in concns. of less than 10 μg. per ml. completely inhibited growth of 5 out of 5 strains of *Bact. alcaligenes*, 7 of 12 strains of *Brucella*, 5 of 11 strains of *Proteus*, 5 of 12 strains of *Salmonella*, 4 of 10 strains of *Eberthella* [*Salm. typhi*], and 1 of 10 strains of *Shigella*. Remaining organisms in these species ranged from moderate to extreme resistance. All

(*Continued on page 52*)

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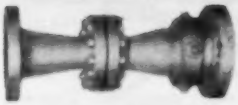

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Most desirable form of primary device for use with inferential meters. Furnished for high or low pressures in cast-iron, cast steel, steel plate, bronze or combinations. Used for measurement of hot and cold water, gases, air, sewage, sludge or chemical bearing liquids.

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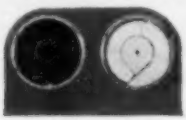
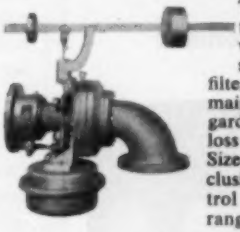
Operates in conjunction with Venturi tubes, flow nozzles, or orifice plates on differential heads of 64 inches and 114 inches of water. Measures over respective ranges of 10 to 1 and 13 to 1 within ± 2%. Wall bracket, panel mounting or floor stand, as desired. For measurement of water, air, sewage, sludge and industrial liquors. Instrument utilizes evenly spaced circular charts.



FILTER GAUGES

Essential for correct filter plant operation. These gauges are available for indicating and recording rate of flow and loss of head. Bed expansion function may be included. Gauges are furnished for operating table or floor stand mounting.

FLOW CONTROLLERS



Type "S" controllers of the Guillotine-balanced valve design are necessary units for correct filter operation. Controllers maintain constant flow regardless of variation of loss of head through filter. Sizes from 3" to 24" inclusive, they maintain control with ± 3% over 5 to 1 range.

AIR INLET (Vacuum Breaking) VALVES

Furnished in 4", 6", 8", and 10" inlet sizes, these valves eliminate possibility of collapse in thin walled pipes due to sudden drop in pressure in gravity flow lines. Float is buoyed to its seat by water pressure and upon loss of buoyancy, float falls admitting air and breaking vacuum.

AIR RELEASE VALVES

Type AGFD air release valves vent air accumulations in pipe lines, increasing pumping efficiency and eliminating air binding at high points in line. Simple, rugged in construction, these valves are obtainable in 1" and 2" inlet sizes in working pressure to 250 p.s.i. Special valves available for pressures to 800 p.s.i.

PITOT EQUIPMENT

Portable pitot rods, manometers and recorders, when used together furnish an over-all picture of actual operating efficiency of distribution systems. By their use, leaks and line breaks in grid systems are readily located. Light in weight, compact in design, equipment is portable in every sense.

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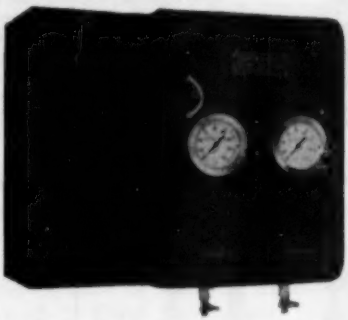

Illustrated above—the CPV-250 (2½ in.) automatic

Available on *better* water softeners and water filters.

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(*Continued from page 50*)

strains tested of *Esch. coli, Friedländer* group and *Pseudomonas* extremely resistant to penicillin. All 9 genera showed strains sensitive to less than 10 μg./ml. streptomycin, but some moderately resistant strains found among *Salmonella, Proteus* and *Pseudomonas* groups. Representative members of each species also tested against penicillin fractions *F*, dihydro *F*, *X* and *K*. Usually these compds. were less effective than penicillin *G*, but penicillin *X* was superior to *G* against *Brucella*. Effects of combinations of penicillin *G*, sodium sulfadiazine and streptomycin on sensitivity and rate of development of resistance to streptomycin of 3 strains of *Proteus*, 1 of *Esch. coli* and 1 of *Ps. aeruginosa* next studied. Three sets of serial dilns. of streptomycin in broth set up; to each tube of one set penicillin added to give final concn. of 1.5 μg. penicillin per ml. and to each tube of another sulfadiazine added to give final concn. of 150 μg. per ml. of this compd. Third set left with streptomycin only. After inoculation with test organism and incubation at 37°C. for 15–18 hr. bacteria showing growth in highest concn. of streptomycin subcultured in broth without antibiotic for 6 hr. and test then repeated with this culture. This procedure repeated daily until organisms showed consistent streptomycin resistance. In another expt. penicillin and sulfadiazine, each in ½ of above amts., both added to serial dilns. of streptomycin. Combination of penicillin *G* with streptomycin had little or no effect except with 1 of 3 strains of *Proteus* which was relatively sensitive to penicillin. Addn. of sulfadiazine reduced amt. of streptomycin required for bacteriostasis of 3 strains of *Proteus* and *Ps. aeruginosa*, and delayed development of resistance of all but 1 of *Proteus* strains. Addn. of penicillin and sulfadiazine reduced amt. of streptomycin causing bacteri-

(*Continued on page 54*)

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CAN NOW DO AN ALL MECHANICAL-JOINT JOB WITH PIPE, FITTINGS, VALVES, AND HYDRANTS

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EDDY VALVE COMPANY

WATERFORD NEW YORK

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(*Continued from page 52*)

ostasis and delayed development of resistance with all 5 organisms.—*B.H.*

Contribution to the Biology of Phenol-splitting Microorganisms. F. Lieb. Gas, Wasser, Wärme (Austria), **3**:101 (June '49). Compilation of studies pertaining to presence, effect and treatment of phenol-contg. wastes discharged into surface waters. Studies on phenol-splitting bacteria show basically 2 types of metabolism: [1] phenol as sole source of carbon, resulting in reduction; and [2] splitting of phenol during growth of organisms with different source of carbon. Specific strains of organisms and culture media described. Effect of temp. tested by using strains isolated at 46°C. and growing them at 22°C. Although slimy growth occurred, no phenol decompn. could be found. Thermophilic and mesophilic cultures isolated from streams unable to split phenol, but cultures from sludge banks able to decompose phenol at 22°C. and 46°C.—*W. Rudolfs.*

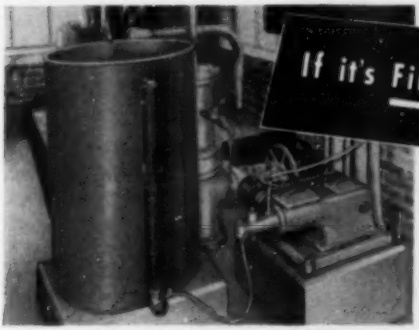
A Quaternary Inactivator. G. R. Goetchius. Soap, **25**:1:131 (Jan. '49). While studying effect of sulfonic acid derivatives on action of quaternary ammonium germicides author found that "Tamol N" (sodium salt of condensed aryl sulfonic acid) inactivated these antiseptics. It was found that action of 5 quaternary compds. in concns. of 1 in 5000 on *Salm. typhi* completely inhibited by 1 in 5000 Tamol N. When *Staph. aureus* was used as test organism, considerably higher concns. of Tamol N needed to inhibit action of quaternary compds. and concns. needed varied with each of 5 germicides. However all inactivated by 2% or less. In this concn. Tamol N had no antibact. action. Since Tamol N highly water sol., stable in soln. and resists autoclaving, inexpensive and not detergent, author recommends its use as quaternary inactivator.—*B.H.*

Use of the Term "Coliform." R. Lovell & C. B. Taylor. British Med. J. (Gt. Br.) (May 7, '49), p. 820. Use of term "coliform" with different meanings by bacteriologists with different interests led Societies for General Microbiology and Applied Bacteriology to appoint combined committee to discuss matter. Tendency in past has been for medical and veterinary bacteriologists to include wide range of bacteria in group and for others to restrict use of term greatly, water bacteriologist, for example, regarding it as synonymous with *Esch. coli* of fecal origin. Recommendations of committee as follows: [1] Term "coliform" means "like *Bacterium coli*" or "coli-like." [2] "Coliform" is adjective and as such has no generic or ecological signif. [3] Proposed that term "coliform" should refer to *Gram-negative rods resembling* Bacterium coli *in morphology and staining reactions but not necessarily in cultural and biochemical characteristics.* [4] Hoped that widest publicity will be given to this definition to prevent term being employed to define different specific types by different workers, or to restrict term to particular branches of bacteriology.—*B.H.*

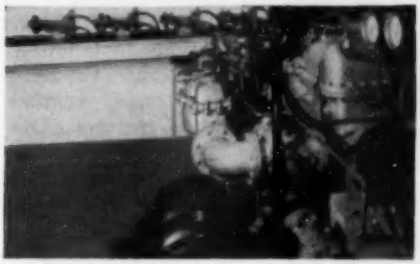
RADIO COMMUNICATIONS

Radio for the Water Engineer. Anon. Wtr. & Wtr. Eng. (Gt. Br.), **52**:161 (Apr. '49). Diversion of inspection personnel and repair gangs in situations requiring speedy action one example of need for rapid communication. It can save time, labor, gasoline and transport costs in testing water mains, checking pumping station performance, regulation of distr. systems and reconditioning mains. Rather high cost of suitable equip. has, with

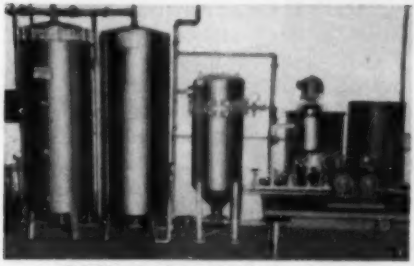
(*Continued on page 56*)



Fluoride treatment for prevention of tooth decay



Hypochlorinating flows ranging from 60 to 3600 GPM



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(*Continued from page 54*)

some authorities, been main deterrent to use of radio. In allocation of licenses and frequency channels, water supply services recognized as being of vital importance and receive favorable consideration. No operating qualifications expected. Connection of private radio to public telephone system not permitted but connection to private telephone line can be permitted. Frequencies available fall into very-high-frequency (vhf.) band which has certain well-defined characteristics; vhf. waves not reflected but entering into upper atmosphere pass straight on; consequently only waves traveling direct from transmitter to receiver used. Transmission local in character and cannot be interfered with by another transmission on same frequency made some distance away. Signals not subject to fading, and relatively free from natural and manmade static. Range from single station is of order of 10–20 mi. Two main methods of operation, simplex and duplex. In simplex, all transmitters and receivers tuned to same frequency. Only one-way conversation thus possible at any one time. Duplex necessitates two frequency channels, and full two-way conversations may be carried on. Modifications of these methods have been devised to meet particular requirements. Both AM and FM modulation of vhf. have been in use for some time. Greater coverage considered obtainable with FM and it has better signal-to-noise ratio. Diversity systems, employing several transmitters to cover wide area, cannot be used with FM. Power output of fixed station transmitters normally restricted to 50 w. Cost of equip. varies, but lies between about £159 for Marconi 10-w. equip. to £215 for Mullard 20-w. equip. All mobile equip. designed for operation from 6- or 12-v. battery and for transport in car or truck. Output from mobile equip. varies from 10 to 20 w. and cost varies from £135 to £200. Mfg. of lighter equip. for vhf. not yet in full swing. Transportable radio telephone designed for operation from 6- or 12-v. battery, high-tension supplies being derived from vibrator unit. Marconi walkie-talkie is completely self-contained vhf. transmitter-receiver designed to be carried and operated without impeding freedom of movement. Weighs only 12 lb., costs £65.—*H. E. Babbitt.*

Brighton Corporation Water Works Radio Communications Installation. ANON. Wtr. & Wtr. Eng. (Gt. Br.), 52:491 (Oct. '49). Equip. consists of 3 10-w. transmitter-receivers. One unit installed as fixed station at Ditchling Road Res. but remotely controlled and operated from engineer's office in town 2 mi. distant. Other 2 units installed on vehicles, one on mains superintendent's car and other on service van. Adjacent to control unit of fixed station and telephone switchboard is internal office telephone, so that communication by all 3 systems is at hand. Control unit comprises telephone handset and case contg. control equip., which provides for switching on and off filament current of transmitter-receiver at reservoir. Telephone handset similar to standard instrument, but loudspeaker replaces customary dialing mechanism; send-receive press switch incorporated into handle of telephone earpiece; and vol. control installed in side of instrument base. At reservoir site transmitter-receiver installed in small pumphouse; power supply, amtg. to about 100 w., being derived from electric light mains. Installation in car follows std. practice of having transmitter-receiver in rear locker, control unit with loudspeaker under dashboard and microphone attached to control unit by cable. In van, app. carried on floor under driver's seat. Territory

(*Continued on page 58*)

THE SEALING EFFECT of a cement mortar lining, applied centrifugally by Centriline, is such that a lining of ¼" thickness will safely span holes up to and including 1¼" diameter under water pressures as great as 200 pounds per square inch. Thus, past or future exterior penetration caused by corrosion or electrolysis will not affect the efficiency of Centrilined mains.

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(Continued from page 56)

not easy for very-high-frequency radio so license granted for 80-mc. band, two-frequency simplex system being employed with one frequency above and one below 80-mc. band. No interference by other transmissions. Far more uses and advantages have already been found for radio than had been visualized and addnl. being found almost daily. Time necessarily wasted in past in awaiting transport materials or in traveling back to depot between each job now put into productive effort. Strangely there has been no adverse comment from men on loss of these enforced "breaks." Radio communication in water supply engineering has come to stay.—*H. E. Babbitt.*

SCALE AND CORROSION

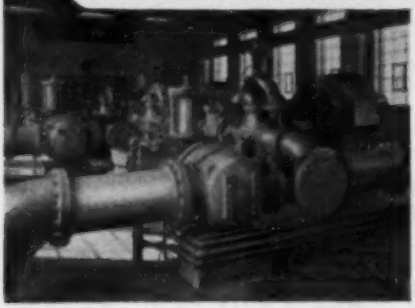
Prevention of Iron and Steel Corrosion: Processes and Published Specifications. C. DINSDALE. Iliffe & Sons, Ltd., London (1948). Consists essentially of series of tables listing processes available for protecting iron and steel from corrosion, and specifications which have been issued regarding such processes. Contents divided into 3 parts, dealing with methods of preventing corrosion, cleaning of metals and codes of practice. First part includes, in 11 sections, details of metallic coatings, org. and inorg. coatings, electrolytic methods and water treatment. Appendix deals with specifications relating to paints and paint compds. Throughout, specifications from many countries besides Britain and U.S. included in tables. In addition to std. techniques, proprietary processes have been listed, with inevitable omissions. Brief introductions to each section given, some of which could have been profitably expanded. For instance, hardly possible to deal adequately with subject of metallic coatings on steel in 10 lines. Book said to be important to engrs. and others concerned with preservation of machinery. Should be especially useful to those who have to advise on protection of iron and steel against corrosion in all sorts of environments. Book well produced and price very reasonable.—*Corr.*

Boiler Scale, Its Formation and Removal. H. HASLINGER. Gas, Wasser, Wärme (Austria) **3**:111 ('49). Scale formed by various salts in solns. have various degrees of hardness and soly. Examples given of rate of scale formation. Porosity of scale can be estd. through formula in terms of weight of vol. of pulverized scale and weight of crystalline scale. Scale does not form evenly over heated surface and depends primarily upon temp., salt concn., character of salts and veloc. of water. Heat losses calcd. for different conditions by use of formulas, showing that scales 3–4 mm. thick cause 60% loss of fuel. Question of scale removal versus softening leads to conclusion that softening only increases time required between removals but does not prevent scale formation. Scale removed either by buffering of water or production of "passivity." Former of little value. Latter method based upon fact that certain metals, especially iron and chromium, not affected by concd. nitric acid when colloidal substances present. For soln. of 1 lb. of scale 2.8–3.0-lb. scale soln. required.—*W. Rudolfs.*

Threshold Treatment of Concentrator Water With Calgon. R. S. YOUNG. Wtr. & Wtr. Eng. (Gt. Br.) **52**:455 (Sept. '49). At concentrator of Rhokana Corp., Nkana, Northern Rhodesia, over 9000 tons copper ore received daily. Process requires 3–4 tons of water per ton of ore. Total hardness of water around 35 ppht. About 2 lb. of lime added per ton of

(Continued on page 60)

Another Water System INSTALLS DE LAVAL PUMPS*



Pumps at the Junction Station. Note provision on bed plates for addition of second pump in series to increase head from 150′ to 300′.

Pumps in series at the Whitestone Station. Three of the units have a capacity of 20 mgd and one a capacity of 10 mgd—all against 300′ head.

*78% of all American cities of over 100,000 population use De Laval water works pumps.

De Laval Pumps Deliver Water *80 Miles*

The cities of Saginaw and Midland, Michigan, receive water from a point 80 miles away in Lake Huron, the closest source of potable water in adequate quantity.

Two pumping stations, the Whitestone Point Station and the Junction Station, serve this entire supply line. The Whitestone Station is equipped with four De Laval pumping units having a combined capacity of 70 mgd against 300′ head. Each of these units consists of two pumps in series.

The Junction Station is likewise equipped with four De Laval pumping units having a combined capacity of 70 mgd. At present, each of these units consists of a single pump operating against 150′ head, provision having been made for the addition of pumps in series in order to double the total delivered head, if necessary.

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CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

(*Continued from page 58*)

ore, adding roughly 20 ppht. calcium hydroxide to water. Adherent scale soon built up on pipelines and metal surfaces. Concn. of vitreous phosphate in treatment of concentrator water is 1 ppm., or about 40 lb./day. Treatment has proved economical. Rate of scale formation has decreased to about 10% of former rate. Treatment will show substantial savings.—*H. E. Babbitt.*

The Role of Zinc in Scale Prevention. E. URION. L'Eau (Fr.) **37**:23 (Feb. '50). Lab. expts. show that addition of zinc to hard water inhibits scale formation. Within certain limits, inhibition is function of Zn concentration. Mechanism of action of Zn analogous to that of metaphosphate; Zn operates in similar dosage range. Inhibition perhaps related to quant. of Zn polymerized, which is adsorbed on microcrystals and solid surfaces, thereby preventing beginning of lime crystallization or formation of CO_2 bubbles.—*W. Rudolfs.*

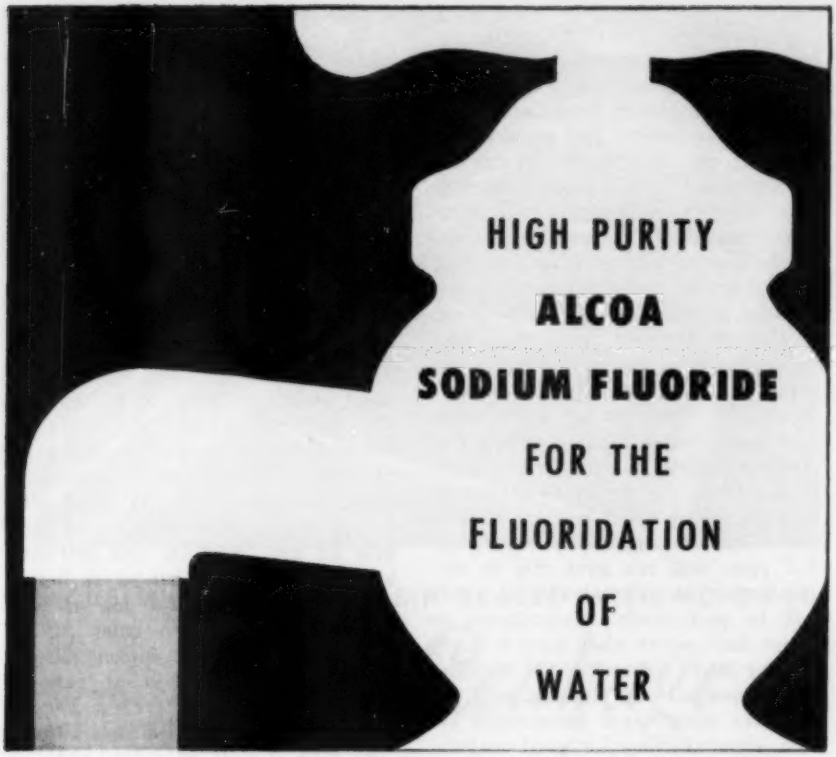
Degassing of Water as a Preventive Against Corrosion. K. WICKERT, K. NOLTEN, J. KROLL & E. IPACH. Arch. Metallkunde (Ger.), **3**:3:105 ('49). Paper in 3 parts: [1] expts. on oxidation of sodium sulfite by molecular oxygen in neutral aqueous solns.; [2] expts. on oxidation of sodium sulfite by molecular oxygen in alkaline aqueous solns.; [3] expts. on oxidation of hydrazine by molecular oxygen in pure water. Expts. on removal of dissolved oxygen from boiler feedwater and condensate described in detail. Reaction rate between sodium sulfite and molecular oxygen slower in alkaline than in neutral solns. Resulting products not actively corrosive if treatment carried out between 20° and 80°C.; at latter temp. excess sulfite should be avoided lest intermediate products of corrosive nature be formed. Treatment with hydrazine gives faster reaction than with sulfite in alkaline solns., but slower than with sulfite in neutral solns. Reaction products, nitrogen and water, noncorrosive, and method very suitable for removal of any residual oxygen left behind after other treatments. —*I.M.*

On the Various Evaluations of the Corrosive Strength of Water. L. W. HAASE. Arch. Metallkunde (Ger.), **3**:3:114 ('49). Author discusses: [1] relationship between carbonic acid content and corrosive action of water on ferrous and nonferrous metals; [2] relationship between free carbonic acid content and temporary hardness of water; [3] effects of alterations in chem. compn. of water in vicinity of metal surfaces, due to reactions between hydroxyl and metal ions, and [4] effects of oxygen depolarization.—*I.M.*

SWIMMING POOLS

The Purification and Control of Swimming Bath Water. R. C. HOATHER & G. J. LAWS. J. Roy. San. Inst. (Gt. Br.), **69**:3:219 (May '49). High std. of control of purif. of water in public swimming pools maintd. in Britain and no evidence of transmission of disease by such water. Criteria of control required indicated in Sec. 233 of Public Health Act ('36) and Model Bylaws VIII A ('39). Water should be clear and bright in appearance, slightly alkaline in reaction and of bact. qual. comparable with drinking water derived from public supply. Attainment of such std. possible only by use of continuous circulation system. Impurities accumulate in pool from costumes and bodies of bathers, with consequent increase in free ammonia and deterioration in org. qual. noticeable to bath super-

(*Continued on page 62*)



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(*Continued from page 60*)

intendent by change in clarity and color. Ideal procedure would be to change water, costly procedure owing to amt. used and to fuel required for warming, etc. Process of free residual chlorination provides valuable alternative, whereby ammonia almost completely oxidized, efficient bactericidal action assured and at same time amt. of org. matter and any color in water reduced. Application of large doses of chlorine to water practiced by pool superintendents for many years, usual procedure being to add considerable quants. of bleaching or hypochlorite soln. after closing time. Residual free chlorine concns. in excess of 0.5 ppm. do not cause discomfort to bathers so long as pH of water kept on alkaline side. Authors suggest that residual of 1–2 ppm. will not give rise to discomfort or complaint and higher figure will be particularly advantageous to maint. bact. purity when there is heavy bathing load. Control of pH of water very important and although acid pH produces more rapid bactericidal action, unsatisfactory for good coagulation and water may be irritating to eyes. Considering all factors pH should be maintd. at 7.5. Alkali in form of sodium carbonate may therefore be required in conjunction with aluminium sulfate for coagulation. Bacteriological examn. for establishing bact. purity of water includes examn. for coliform organisms, particularly *Esch. coli*, as prime index of organisms of excretal origin. Has been suggested that streptococci, which include buccal as well as intestinal types, would prove better index for swimming pool water than coliform group, but complete freedom from these organisms might prove too stringent a criterion. Clarity of water very important from point of view of safety, as well as of appearance, and bottom should be clearly visible at deep end. Method of detg. clarity by means of target and viewing tube described. Suggested that clarity of at least 30′ should be aimed at under normal conditions. Report of discussion on paper follows, together with replies by authors to particular points made by speakers.—*B.H.*

ION EXCHANGE

Determination of the Total Cation Content of Water. HEINZ HOEK. Chimia (Switz.), **2**:227 ('48). Use made of ion exchange to det. metallic ions contained in H_2O. Amberlite IR-100 employed to accomplish this quantitatively. Characteristics of this ion-exchange material given. Anal. conducted in app. which consists of glass tube 15 mm. in diam. and 350 mm. high, containing exchanger to height of about 270 mm. 300 ml. of H_2O under test allowed to enter top of tube from separatory funnel, passing through exchanger bed at rate of about 20 ml. per min. First 200 ml. discarded and final 100 ml. titrated with 0.1*N* NaOH to yellow endpoint of methyl orange. Bed of exchanger may be used for 5 detns. Table illustrating results of tests of 2 samples of H_2O included.—*C.A.*

Comparative Investigations on Ion Exchange. H. REICHELT. Chem. Tech., Ver. Chem. App. (Ger.), **1**:28 ('49). Expts. made on H_2O of about 3° carbonate and 8° total hardness, exchange material being in vertical glass tube 200 mm. in diam. with 900 mm. depth of material, direction of flow being reversible. Upward flow gave best results by keeping exchanger loose and free from slime. Expts. run until effluent H_2O fell to about 0.15° hardness, when material regenerated. Seldom possible to obtain strictly comparable results, so this report based on avg. of about 100 trials. Results

(*Continued on page 64*)

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Thanks to NO-OX-ID waterproof coatings, finished water and profits no longer seep through cracks in the clarifying basin in this California plant. Engineers in the Ventura Filtration Plant, after several attempts to stop disfiguring leakage into pipe gallery, had the clarifier walls cleaned of lime sludge deposits and then coated with tough, chemically inhibited NO-OX-ID and two layers of fabric wrapping.

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(Continued from page 62)

shown by 12 charts. Artificial resins most efficient, silicates least.—*C.A.*

Silica Removal by Ion Exchange. Joseph McGarvey & Francis X. McGarvey. Power, **94**:2:93 ('50). Troubles due to Si in feedwater outlined. Various methods to bring about its removal cited. Weak-base anion-exchange resins not always effective. Strongly basic anion-exchange resin found which was satisfactory. As all waters not alike, several combinations listed to fit various kinds of supply.—*C.A.*

OTHER ARTICLES NOTED

Recent articles of interest, appearing in American periodicals not abstracted, are listed below.

Installation and Economics of Placing Magnesium Anodes at Leaks Repaired on a Pipeline. J. A. Holloway. Corr., **6**:5:157 (May '50).

Ground Water Resources of the Greater Boston Area, Massachusetts. H. N. Halberg & H. L. Pree Jr. J. Boston Soc. Civ. Engrs., **37**:2:204 (Apr. '50).

Water Report [Western States]. Paul A. Ewing. Reclamation Era, **36**:5:98 (May '50).

Water Supply. A.P.H.A. Section Committee Report. Am. J. Pub. Health Yrbk., **40**:5:Pt.2:110 (May '50).

Controlling Cattail with 2,4-*D*. Max Wilson. Reclamation Era, **36**:6:108 (June '50).

The Newburgh-Kingston Caries Fluorine Study. I. Dental Findings After Three Years of Water Fluoridation. David B. Ast, Sidney B. Finn & Isabel McCaffrey. Am. J. Pub. Health, **40**:6:716 (June '50).

Newburgh-Kingston Caries Fluorine Study. II. Pediatric Aspects—Preliminary Report. Edward R. Schlesinger, David E. Overton & Helen C. Chase. Am. J. Public Health, **40**:6:725 (June '50).

Relationship of Coliform Bacteria to Gas Production in Media Containing Lactose. Cecil W. Chambers. Pub. Health Repts., **65**:19:619 (May 12, '50).

Sampling for Evaluation of Stream Pollution. C. J. Velz. Sew. Ind. Wastes J., **22**:5:666 (May '50).

The Pollution of the Charles River. Murray P. Horwood, John D. Frame & Ross E. McKinney. J. Boston Soc. Civ. Engrs., **37**:2:170 (Apr. '50).

A.W.W.A.

Code of Practice

●

The A.W.W.A. Code, printed in two colors on a heavy 10 × 17-inch sheet, suitable for framing is now available for distribution to members.

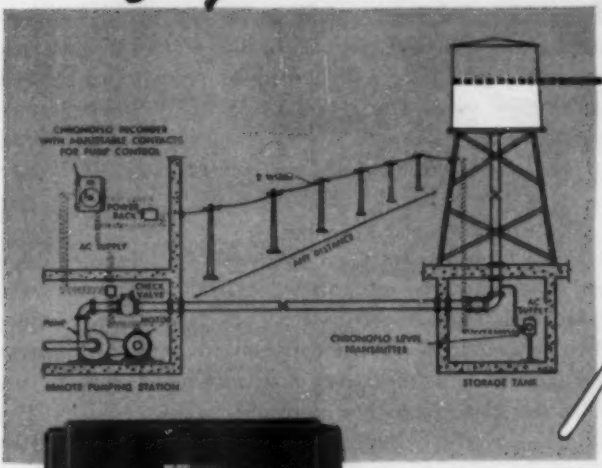
For your copy, send only ten cents in coin or stamps to cover postage and handling charges. There is no charge for the document.

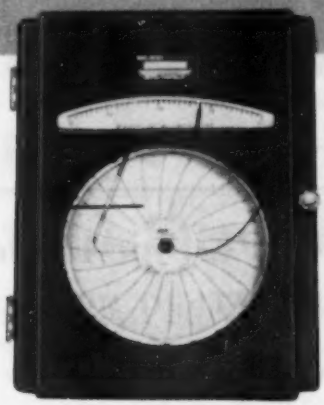
●

American Water Works Association

500 Fifth Ave., New York 18, N.Y.

Keep it on the LEVEL





For fully automatic control of water level in remote tanks, standpipes, or reservoirs, install BUILDERS CHRONOFLO. This simple electrical telemeter not only transmits information on water level from remote locations to the central operating point — it's also an automatic pump control system. You have the convenience of accurate indication of level, plus the assurance that your pumps will swing into action the minute they're needed. Little wonder so many water works are adopting this efficient Chronoflo Pump Control System. For complete information and descriptive Bulletins, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 365 Harris Avenue, Providence 1, Rhode Island.

BUILDERS PRODUCTS

The Venturi Meter • Propelofio and Orifice Meters • Kennison Nozzles • Venturi Filter Controllers and Gauges • Conveyoflo Meters • Type M and Flo-Watch Instruments • Wheeler Filter Bottoms • Master Controllers • Chlorinizers — Chlorine Gas Feeders • Filter Operating Tables • Manometers Chronoflo Telemeters

BUILDERS PROVIDENCE
Instruments

(*Continued from page 20*)

Loss of its two largest customers enabled the Fairmount, Ind., municipal water works to obtain a 50 per cent rate increase. Evidence that the closing, in 1948, of a General Foods plant which had purchased one-third the utility's output, and the development, by the second largest customer, of a private water system, had combined to reduce the utility's income below the break-even point, convinced the Indiana Public Service Commission that the increase was in order. The Fairmount department, its sales slashed, had made only $800 in 1948, had emerged from 1949 with a deficit of $1,637.

Much water which was supposed to go under the Clay Street bridge in Newark, N.J., had to be detoured on to it when 1950's first heat wave struck last month. Meanwhile much traffic which was supposed to go over the bridge also had to be detoured. What happened was the bridge was raised to permit passage of a Passaic River boat and then stuck in the raised position because the steel beams had expanded with the heat. The stuff under it, up, sprayed over it brought it down—water, of course, the universal solution.

(*Continued on page 68*)

M-SCOPE Pipe Finder

LIGHTWEIGHT MODEL

Catalog No. 25K

On Request

JOSEPH G. POLLARD CO., INC.

Pipe Line Equipment

New Hyde Park **New York**

reduce water line costs with this "slimming diet"

Excess weight and material in a water line is expensive and unnecessary. With Armco Welded Steel Pipe, you choose the exact wall thickness you need ($\frac{9}{64}$- to $\frac{1}{2}$-inch) in any diameter (6 to 36 inches). You save money and metal.

Armco Steel Pipe saves on installation, too. Lighter weight simplifies handling. Lengths up to 50 feet mean fewer joints—less assembly work. Field connections go in fast with any of the standard couplings or by field welding.

You'll also find that Armco Welded Steel Pipe is amply strong, free from leakage and provides continued high flow capacity. Use it with confidence wherever you need water supply or force mains. Write for complete data. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 3580 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation.

ARMCO WELDED STEEL PIPE

Meets A.W.W.A. Specifications

ARMCO

(*Continued from page 66*)

A new standard for Cast Brass Solder-Joint Fittings (B16.18–1950) to be used with copper water tube has been developed under American Standards Assn. auspices. The standard supersedes the American Standard Soldered-Joint Fittings (A40.3–1941) which had been intended primarily for plumbing. The new standard was planned to cover other uses as well. Copies are available at 75¢ each from the American Society of Mechanical Engineers, 29 W. 39th St., or American Standards Assn., 70 E. 45th St., both in New York.

Use packaging—industry's new technique of putting its products in containers which are designed for a secondary use—is beginning to get out of hand. It was bad enough last time we had occasion to buy a box of bonbons to be offered them in a mirrored plush-lined box intended ultimately for jewels. (Jewels, no less, and *why*, do they think, we're buying candy in the first place?) But a later straw has been the report that one manufacturer of medicinal chemicals is marketing a benzedrine inhaler in the form of a cylinder which can be used as an effective casting bait. What next, then, but a gum wrapper which can be used as a dollar bill?

Time was when industry was content to leave such matters to the consumer's ingenuity. And we're inclined to believe that the generations of Americans who drank their fruit juice out of odd-sized cheese glasses and their other beverages out of honest-to-goodness jelly jars were no less happy than those who now buy their cheese and jelly unsubtly swathed in crystal. Remembering men who smoked cigars primarily to get the boxes and the thrill of discovering that our empty cigarette tin was just the right size for our wife's bobby pins, we begin to fear now for our rugged individualism.

But wait, there still is hope. The water works industry, which may well have started the whole business of use packaging by providing its product in a package which made a good electrical ground, is even now beginning to use plastics for its service lines.

Harold B. Gotaas, chairman of the Div. of San. Eng. at the Univ. of California, is making a tour of ten western European countries for the World Health Organization. His mission is to observe engineering and sanitation projects in these countries and to discuss engineering developments in the U.S. with engineers abroad.

George E. Shafer has been appointed chief engineer of Armco Drainage and Metal Products, Inc., with responsibility for the Product Engineering and New Product Development Departments, as well as the Sales Engineering Dept. he previously headed.

(*Continued on page 70*)

Will Sodium Fluoride help preserve this smile?

THANKS TO dental research on ways of reducing tooth decay, more and more of our children will grow up with sound, strong teeth. For example, one phase of present-day research is indicating that Sodium Fluoride may become an important weapon for combating tooth decay.

Water Fluoridation

FOR SEVERAL YEARS, a number of communities have been adding Sodium Fluoride to municipal water supplies low in natural fluorine content. Preliminary reports indicate a 25 to 30% lower rate of tooth decay among children drinking these treated waters.

FROM SUCH STUDIES, dental, municipal, and public health authorities will shape plans for the future—possibly extend these preventive measures to scores of other cities and towns the nation over.

Regular Dental Care

• • •

From municipalities using its Sodium Fluoride, General Chemical has gained considerable knowledge of the mechanical aspects of water fluoridation. Its Technical Service is available to officials considering similar programs. For additional information, consult the nearest General Chemical office listed below.

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport Buffalo • Charlotte • Chicago • Cleveland • Denver • Detroit • Houston Jacksonville • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh Providence • San Francisco • Seattle • St. Louis • Wenatchee and Yakima (Wash.)
In Wisconsin: General Chemical Company, Inc., Milwaukee, Wis.
In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

BASIC CHEMICALS
GC
FOR EFFICIENCY IN INDUSTRY

(*Continued from page 68*)

With the easing of water shortage in the metropolitan New York-New Jersey area—because of, despite or with possible help from the City's rainmaker—experts who have had an implicit faith that the deficiency was merely the result of a flat tire on the hydrologic cycle received a rude shock. Detonator was Dr. David R. Bates of the University of London, who, before a group of upper-atmosphere scientists attending a Cal Tech symposium, announced the discovery of a five- to ten-mile thick band of water vapor which, swept from the earth to an altitude of forty miles, can never return. This escape of moisture from the earth's surface, he explained, was due to the breaking up of the water molecules into hydrogen and oxygen under the influence of the high-altitude ultraviolet rays. Carrying the revelation elevation still further, Dr. R. Penndorf of the Air Force Cambridge Research Labs spoke of another atmospheric layer four hundred miles up, where the atmosphere is so light that molecules do not exist, but are separated into atoms which presumably escape into space. We, who have always felt that "dry up" was an accurate term, have reason to rejoice at so authoritative a confirmation; but hydrologists, whose conclusions have been universally based upon the theory that "what goes up must come down," are quite literally *up*set, if not downcast. If this doesn't explain why May in the Northeast was so rainy yet produced so little rain, just sue Dr. Howell or the city of New York—everybody else is. Anyhow, reservoir levels are over 90 per cent and on their way up.

One good reason why New York City's reservoir levels are up was indicated by Water Commissioner Carney in estimating that the water saved by New Yorkers in their conservation campaign between last December and June would cover Manhattan Island's 22 square miles to a depth of 12 ft. And if you think that might be a good idea, please restrain yourself until a wetter year. After all, things must still be pretty serious when water department employees can be happy about a rain-out of their annual picnic. Or was someone twisting their arm?

The Goldak Co. has developed a combined pipe locating and leak detecting instrument known as the Dualtronic, to meet the need for a multipurpose electronic device of this type. Further information is available from the company at 1502 W. Glenoaks Blvd., Glendale, Calif.

McCabe-Powers Auto Body Co. of St. Louis has purchased the American Coach & Body Co. of Cleveland, manufacturer of automotive bodies and equipment for public utilities. Both plants will continue operations under the new arrangement, but the public utility business will be conducted by the Powers-American Div. of the firm.

(*Continued on page 72*)

COCHRANE

SLUDGE CONTACT REACTORS

For the Clarification of Water and the Recovery of Waste in Process

COCHRANE's specialization in the conditioning of industrial water supplies over the past fifty years and the combined years of experience of Cochrane engineers in that field, is your assurance of satisfactory service from any Cochrane installation. In the new method of sludge contact or removal by flocculation of impurities, turbidity, color or hardness, the Cochrane Sludge Contact Reactor accomplishes all these functions with complete efficiency and surprising economy. A new bulletin, Publication 5001, is available and will be sent on request.

Cochrane Sludge Contact Reactors are applicable to municipal and industrial plants for coagulation and/or softening, removal of turbidity, color, hardness, taste, for fluoride removal, de-alkalization, iron and manganese removal, etc.

COCHRANE CORPORATION

3124 N. 17th Street Philadelphia 32, Pa.

(*Continued from page 70*)

Water conservation, which has long made good sense, now at last also appears to be making good business. Thus, a survey by the Plumbing and Heating Industries Bureau in Chicago reveals that manufacturers have found it wise to place an increasing emphasis on the development of plumbing fixtures and fittings that will provide "maximum utility with minimum water consumption." Available, as a result, are water-saving showerheads, self-closing faucets and valves, water closets that operate efficiently with less water, lavatories with smaller bowls and smaller, built-in bathtubs. And with the Bureau's program of publicizing the economy of replacement as against repair of faulty fixtures, we one day should be able to make at least a small dent in our ever increasing record per capita consumption. Only trouble is other factors are involved. Thus, for instance, we recently noted in the *Lamp,* publication of the Standard Oil Co. (N.J.), that it now requires 23 gal. of water to refine 1 gal. of oil and that a new plant designed to make synthetic gasoline is expected to use 377 gal. of water per gal. of product. The answer, of course, is to drink beer.

Ground water investigations in New York State will continue for another year as a result of the renewal of cooperative agreements by the U.S. Geological Survey and the Water Power and Control Commission of the New York State Conservation Dept. The jointly financed studies will continue throughout the state and on Long Island, where various county authorities also sponsor them.

Organization and consolidation of concrete pipe industry groups (see April P&R, p. 2) continues with the formation of the American Concrete Agricultural Pipe Assn. The new group is affiliated with the existing American Concrete Pipe Assn. and the American Concrete Pressure Pipe Assn. in the coordinating Concrete Pipe Associations Inc. As managing director of the latter group, Howard F. Peckworth will have the job of distinguishing ACAPA from ACPA from ACPPA from CPA.

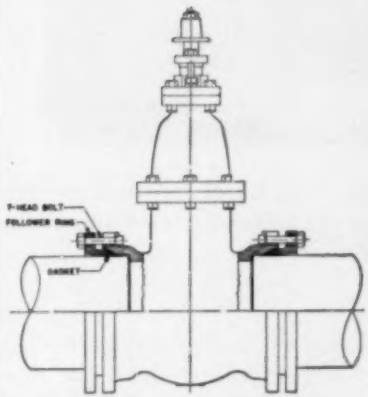
George H. Buck, of the New York consulting firm of Buck, Seifert & Jost, has been elected president and a director of the Hackensack, N.J., Water Co., succeeding Henry L. deForest. The relationship between the consulting firm and the water utility goes back many years, for, in addition to having had a consultant-client relationship, Buck's organization had been founded by Nicholas S. Hill Jr., a former president of the Hackensack company.

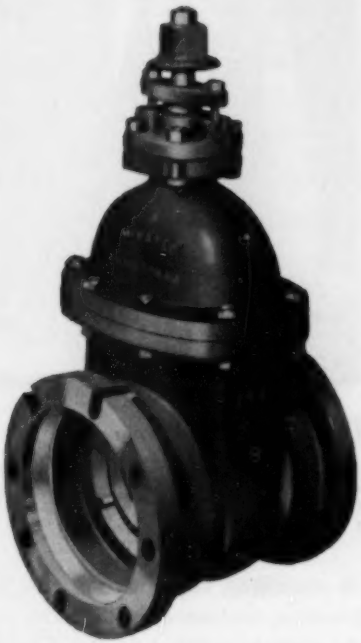
Fred M. Randlett, vice-president and general manager of the Robert W. Hunt Co. of Chicago, has retired and is returning to Portland, Ore., where he was at one time head of the water department.

(*Continued on page 74*)

M H HYDRANTS and VALVES

EASY TO INSTALL MECHANICAL JOINT





M & H Mechanical Joint Hydrants and Valves are furnished for use with Standardized Mechanical Joint Cast Iron Pipe or with plain-end Bell and Spigot Pipe. The Joint has a triangular shaped stuffing box in which a gasket is compressed by bolting up a Cast Iron Ring or Gland with a ratchet wrench —the only tool required. Joint pouring is eliminated.

Features include: (1) Fast and easy installation, (2) unskilled labor, (3) construction economy, (4) joint deflection, (5) leak-tight. We furnish Standardized Mechanical Joint Valves, Hydrants and Cutting-In Sleeves. WRITE FOR CIRCULAR 49.

M & H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

(Continued from page 72)

Debt-free is the Metropolitan Utilities Dist. of Omaha, Neb., as the result of making the last payment on a 1920 bond issue. Frank Frost, chairman of the board, is shown signing the payoff check for $435,000, as

Walter Byrne, general manager, looks on. The district has now paid off over twelve and a half millions in bonds while increasing its plant value to nearly 28 millions, since purchasing the water plant in 1912 and the gas plant in 1920.

A manager, superintendent or field engineer is available for work in construction, equipment installation, processing or maintenance in the water supply, sewage or allied fields. Until recently a construction engineer and consultant for a cement plant in the Philippines, his previous experience includes the superintendency of several mining and quarrying companies in Florida and Virginia, and of several chemical plants. He was also superintendent of a New York water supply and was responsible for water supply and sanitation in many of the other plants he managed. Returning to the U.S. soon, he is free to travel anywhere in the country, but would prefer a small town location. Those interested should get in touch with this A.W.W.A. Member via Box 750, Journal American Water Works Assn., 500 Fifth Ave., New York 18. Inquiries will of course be handled confidentially.

(Continued on page 78)

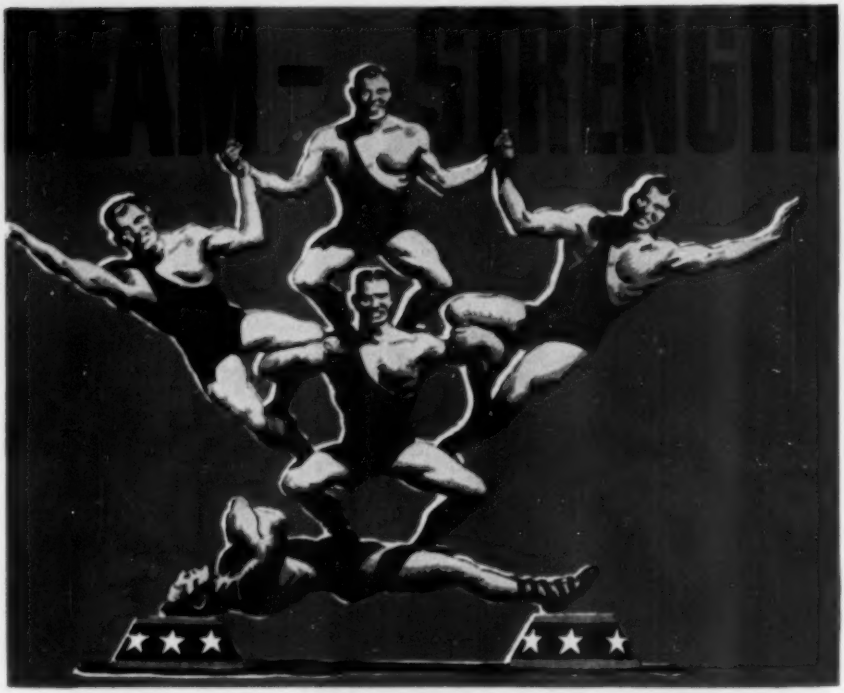
For
repairing bell and spigot joint leaks

In the SKINNER-SEAL Bell Joint Clamp, gasket is completely SEALED and protected by Monel Metal Band. Massive ¾" high-tensile steel bolts, cadmium plated. This speedy one-man installation cuts repair costs.

Write for Catalog!

M. B. SKINNER CO.
South Bend 21, Indiana

SKINNER-SEAL BELL JOINT CLAMP



Without beam strength—or, for that matter—without all of the strength factors listed opposite—no pipe laid 100 years ago in *city streets* would be in service today.

But, in spite of the evolution of traffic from horse-drawn vehicles to heavy trucks and buses—and today's vast complexity of subway and underground utility services—cast iron gas and water mains, laid over a century ago, are serving in the streets of more than 30 cities in the United States and Canada.

Such service records prove that cast iron pipe combines all the strength factors of long life with ample margins of safety.

No pipe that is provably deficient in any of these strength factors should ever be laid in city streets.

Cast Iron Pipe Research Association,
Thos. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3.

CAST IRON PIPE

Strength factors of Long Life !

No pipe that is provably deficient in any of these strength factors should ever be laid in city streets

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

CRUSHING STRENGTH

The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

SERVES FOR CENTURIES

(*Continued from page 74*)

The water business is booming these days—literally and loud. Out in Belleville, Mich., for instance, it was a 125,000-gal. ground storage reservoir which sounded off when Supt. R. G. Atyeo attempted to remove a sleet-stuck manhole cover by a blowtorch thaw. The operation was successful, but the impatient Mr. Atyeo almost died, being blown backwards down the slope to the river and suffering severe burns around head and arms. Cause of the boom was the methane gas released from the stored well water into the improperly vented reservoir and ignited by the flame from the torch. Impersonal result was the raising of the reservoir roof enough to damage supporting columns and to open large cracks in roof and side walls.

Then in Salem, N.J., a somewhat similar occurrence on a smaller scale remains unexplained. There it was a Mrs. Charles Crosier, housewife, who was burned and blasted, when she opened her kitchen water tap in preparing breakfast for the family. Cause of the boom was illuminating gas which collected in the service pipe, but how is a head-scratcher which fire department and gas company officials haven't yet solved. Meanwhile, the Crosier's are out one kitchen window and have some well-charred woodwork above the sink to remind them of the day they blew their tap.

In the water works field, it's bust with every boom.

Woofproof Your Metermen

Here's a bible of bark and bite that will enable you to improve both your personnel relations and your public relations. See that every meter reader gets a copy. Make him read it! Make him heed it!

Under the cover reproduced herewith, A.W.W.A. has, in response to the demand of several meter departments, reprinted Bruce McAlister's "Bow-wow, Mister Meterman" as it appeared in the July issue of **Public Relations at Work.** As a six-page booklet, this practical advice to the doglorn is now available at a nickel per copy—much less than the cost of a single patch in the seat of your pants.

Order your copies now from Department K-9 of:

AMERICAN WATER WORKS ASSOCIATION

500 Fifth Avenue **New York 18, N.Y.**

2,500,000 Gallons per Cubic Foot of Exchanger...

. . . and still going strong! That's the record set by AMBERLITE IR-120 in municipal water softening.

AMBERLITE IR-120 successfully resists waters that dissolve, wear and incapacitate zeolites. Waters low in silica have no effect on this non-phenolic, polystyrene-type cation exchange resin. It resists chlorine and attrition. And, most important in municipal water softening, AMBERLITE IR-120 gives long, high-capacity, trouble-free, economical service—even at extremely low regeneration levels.

Next time you talk to your consulting engineer, or to a manufacturer of water conditioning equipment, ask him about AMBERLITE IR-120—as a replacement for zeolites that have fled the bed, or as the exchanger in a new softening installation.

Meanwhile, why not write to Dept. WWI-6 for your free copy of our pamphlet on AMBERLITE IR-120?

AMBERLITE is a trade-mark, Reg. U.S. Pat. Off. and in principal foreign countries.

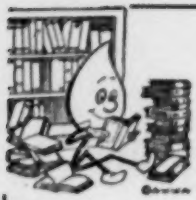
CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

The Resinous Products Division was formerly The Resinous Products & Chemical Company



The Reading Meter

Kent's Mechanical Engineers' Handbook. *In two volumes: "Design and Production" (Colin Carmichael, ed.) and "Power" (J. Kenneth Salisbury, ed.). Wiley Engineering Handbook Series, John Wiley & Sons, New York (12th ed., 1950) $8.50 each.*

In this latest edition, both volumes have been almost completely rewritten, according to their editors. The design and production volume covers such topics as are involved in the selection of materials, design principles, the design and selection of machine components, production processes and equipment, and mathematical tables. The power volume includes, among other subjects, sections devoted to piping, pumping and instrumentation.

Federal Services to Cities and Towns. *Robert H. Blundred and Donoh W. Hanks Jr. American Municipal Assn., 1313 E. 60th St., Chicago 37, Ill. (1950) $5.*

An 81-page, paper-bound index to services offered by U.S. government agencies to local governments. The services, available without charge unless otherwise noted, range from A to Z (specifications for Abbatoirs to information on Zoo administration) and include such items in the water works field as information on joint geologic investigations, grants for water pollution control planning, information on water conservation from the Soil Conservation Service, etc.

PALMER *Filter Bed* AGITATORS

Prevent Sand Beds From Cracking
Eliminate Mud Balls
Save Wash Water
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Higher Rates of Filtration

STUART CORPORATION, 516 N. Charles Street, Baltimore 1, Md.

HYDRO-TITE

WHEN YOU WENT COURTING . .

A pair of "Bull Dogs" like these and a three-inch starched collar were standard equipment. Probably a sailor straw with a gaily striped band rounded out the ensemble.

Even back in those days HYDRO-TITE was doing its job of making joints in cast iron water mains that were being laid away for keeps.

Styles have changed but HYDRO-TITE is still doing its job. Those joints are right there serving you twenty-four hours a day.

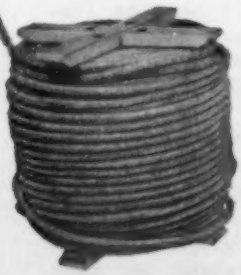
HYDRO-TITE is still made in powder form packed in 100-lb. moisture-proof bags, and now is obtainable also in "LITTLE-PIG" solid form in 50-lb. cartons.

Let HYDRO-TITE go to work for *you*.

PROTECT YOUR MAINS BY USING

FIBREX

THE BACTERIA FREE JOINT PACKING.



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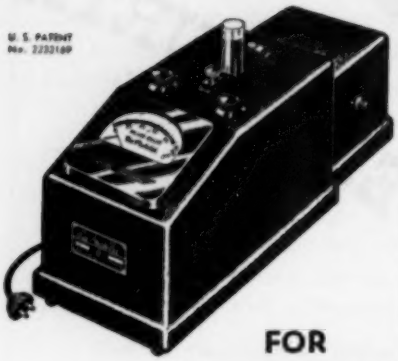
Hellige-Diller

PHOTOELECTRIC COLORIMETER



FOR

WATER ANALYSIS

This Hellige-made Colorimeter has proved its dependability in more than a thousand installations. Equipped with seven light filters, a sensitive photoelectric cell, and microammeter, the colorimeter has the utmost differential response and is ideal for water analyses. Operation of the instrument is extremely simple so that determinations can be made with speed and accuracy.

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HEADQUARTERS FOR COLORIMETRIC APPARATUS

Service Lines

A combination aerator, coagulator and sedimentation basin known as the Process Oxidator is the subject of a 12-page bulletin, No. 106, issued by Process Engrs., Inc., 6381 Hollywood Blvd., Los Angeles 28, Calif. The unit is claimed to offer advantages in efficiency and economy either in water or sewage treatment.

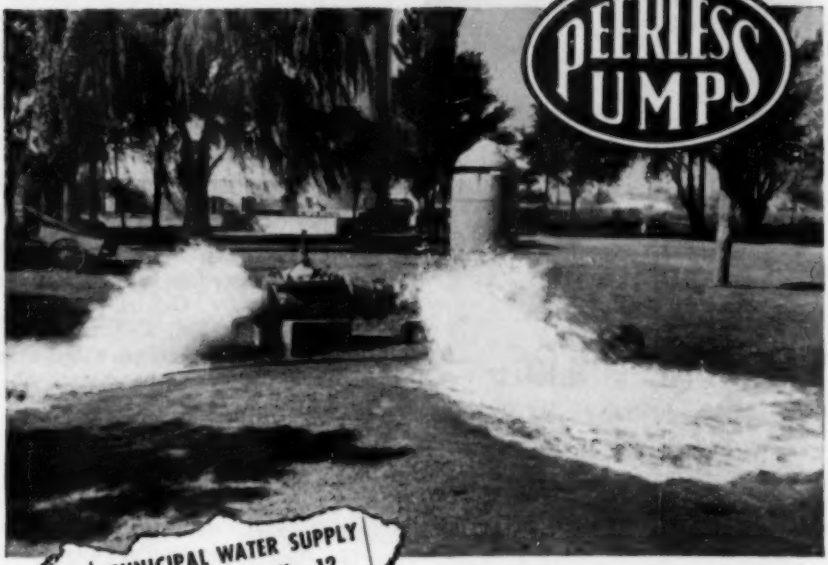
"Chlorine Treatment of Municipal Water" is the subject of a 4-page bulletin, A-1A-4, issued by Fischer & Porter Co., 1000 County Line Road, Hatboro, Pa. Flow diagrams illustrate typical applications.

Braided asbestos packing for cast-iron, concrete and vitrified clay bell joints are the subject of a folder issued by Anchor Packing Co. of Philadelphia. The jointing material is saturated with a non-hardening bitumastic material. Weights, dimensions and other descriptive information are offered in the folder, which may be obtained from the company at 100 Sixth Ave., New York 13, N.Y.

An "Enthalpy-Temperature Diagram for Chlorine," suitable for mounting or framing, has been prepared by Diamond Alkali Co., 300 Union Commerce Bldg., Cleveland 14, Ohio. In order to attain completeness, compilers of the chart were forced to extend the limited data available by extra- or interpolation, but the graph is considered sufficiently reliable for most purposes.

(*Continued on page 84*)

FAST-GROWING SOUTHWESTERN CITY BRINGS IN POWERFUL WATER PRODUCER



MUNICIPAL WATER SUPPLY SYSTEM WELL No. 12 DISCHARGES AT RATE OF 15,000,000 GALS. A DAY

The 3,000-gpm pump with its 200-hp motor was installed in the well. With a free discharge from the twelve-inch open pipe and an eight-inch open nipple on the side of the discharge pipe, the maximum flow was estimated at about 10,000 gpm with a draw-down of only 1½ ft. It is estimated that this eighteen-inch well could furnish 15,000 gpm.

Reprinted from Water Works Engineering

CUT YOUR OVERHEAD *underground* with Peerless Deep Well Turbine Pumps

Follow the lead of progressive communities by installing modern, efficient Peerless deep well turbine pumps. Their superior design, high quality construction, high operating efficiency will cut your overhead underground. Make your standard of pump operation the Peerless standard. Write for Bulletin B-141-3 which describes Peerless vertical turbine deep well pumps in detail.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Factories: Los Angeles, California, and Indianapolis, Indiana
Offices: New York; Atlanta; Fresno; Los Angeles; Chicago; St. Louis; Phoenix; Dallas, Plainview and Lubbock, Texas.

APPROVED
by UNDERWRITERS' LABORATORIES, Inc.

GREENBERG
Independently Valved HYDRANTS
for non-freezing climates

Western water works engineers and fire chiefs were the first to approve Greenberg California-type fire hydrants. Now, after exhaustive tests, Underwriters' Laboratories, Inc. has confirmed your judgment.

Greenberg No. 74 and 76 hydrants are equipped with independent valves of a new type which open quickly and easily, allowing full flow with minimum resistance. They close tightly without water hammer. A major improvement over the old "cork in bottle" type valve!

Other innovations such as you would expect of the people who evolved the California-type hydrant 75 years ago are shown in the free booklet "Hydrants by Greenberg." May we send you a copy?

STABILITY since 1854

M. GREENBERG'S SONS
765 Folsom St. • San Francisco • Calif. • EXbrook 2-3144
Los Angeles • Seattle • Portland • Salt Lake City • Denver
El Paso • New York • Hartford • Washington, D.C.

(*Continued from page 82*)

A folder explaining how "Calgon Controls Corrosion" has been issued by Calgon, Inc., Pittsburgh, Pa. Applications under different conditions are discussed and described.

Dorrco Flash Mixers and Flocculators are the Subject of Bul. 6971 of the Dorr Co., Barry Pl., Stamford, Conn. Illustrations of applications and descriptive text point out the advantages and operating characteristics of the units.

A "Cushioned" Swing Check Valve is featured in a 4-page bulletin issued by Golden-Anderson Valve Specialty Co., Keenan Bldg., Pittsburgh 22, Pa. The valve utilizes an exterior air chamber to obtain the cushioning effect.

Handling of lubricants in a simplified, cost-reducing manner is the subject of a booklet issued by the Alemite Div. of Stewart-Warner Corp., 1826 Diversey Parkway, Chicago 14. Entitled "Eleven Ways to Cut Production Costs," the book discusses color coding of lubricant containers for identification, the use of special pumps to transfer lubricant from drums to smaller containers, the spot-identification of machine bearings to indicate the maintenance required, etc.

A catalog of microscopes for water and sewage analysis use is being offered by American Optical Co., Scientific Instrument Div., Buffalo 15, N.Y. The catalog is designated as No. M142.

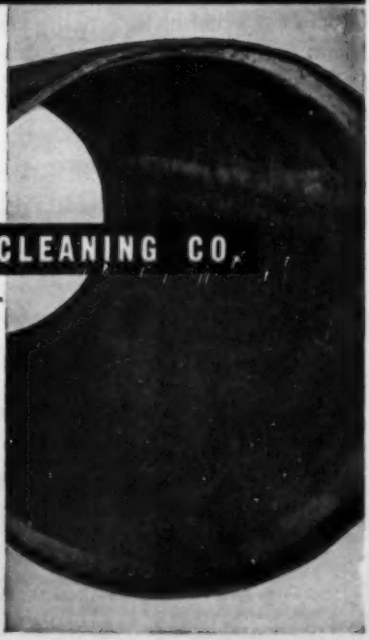
A sliding card selector intended to aid industrial safety directors in choosing proper safety glasses for 69 different jobs has been prepared by Bausch & Lomb Optical Co., and is available from local representatives. Frames are keyed to the specific hazards of each occupation.

With seven miles of badly corroded 36" and 48" steel pipe up for replacement at an estimated cost of $1,800,000., the City of Montreal reconditioned the entire line at a total cost of only $205,000. — a saving of $1,595,000.

Reconditioning included a thorough cleaning and removal of incrustation and debris by the National Water Main Cleaning Co. after which the cleaned surface was centrilined. Final results indicate reduced friction losses, improved carrying capacity and permanent protection against leakage and internal corrosion.

cleaning and reconditioning water main
SAVES MONTREAL $1,595,000

Why not let our engineers find out if similar savings can be effected in your city? No obligation of course!



NATIONAL WATER MAIN CLEANING CO.

50 CHURCH STREET, NEW YORK 7, N. Y.

ATLANTA, GA., 333 Candler Bldg. & P. O. Box 9—Station E • BOSTON, 115 Peterboro St. • CHICAGO, Room 1336, S. Michigan Ave. • KANSAS CITY, MO., 406 Merchandise Mart, 2201 Grand Avenue • LOS ANGELES, 448 S. Hill Street • LITTLE FALLS, N. J., P. O. Box 91 • OMAHA, 3812 Castellar Street • RICHMOND, 210 East Franklin Street • SPRINGFIELD, MO., 1301 Prospect Ave. • SALT LAKE CITY, 149-151 W. Second So. St. • SAN FRANCISCO, 681 Market St. • SIGNAL MT., TENN., 204 Slayton St. • FLANDREAU, S. D., 315 No. Crescent St. • MONTREAL, 2028 Union Ave. • VANCOUVER, B. C., 505 West 1st Avenue • WACO, P. O. Box 887 • WINNIPEG, 576 Wall St. • HAVANA • SAN JUAN, PUERTO RICO • BOGOTA • CARACAS • MEXICO CITY.

Section Meeting Reports

Indiana Section Meeting: A well balanced program was favorably received by 264 registrants at the 42nd Annual Meeting of the Indiana Section. The State Board of Health and Purdue University cooperated in the sessions held on the West Lafayette campus April 26–28.

After a welcome by Chairman Marshall P. Crabill, H. H. Gerstein, chief filtration chemist of Chicago's South District Filtration Plant, presented a paper on "Preparation of Water for Filtration" which he coauthored with John R. Baylis, engineer of water purification. H. J. Draves, superintendent at Michigan City, and Oscar A. Newquist, manager at Muncie, led the discussion. R. W. Aston outlined methods used in "Chlorine Dioxide Treatment" and the results that can be expected. In commenting on his experiences with chlorine dioxide at Valparaiso, Richard Coote stated that he had such success that folks were asking for water again in the restaurants. Lawrence J. Killion found that chlorine dioxide helped the water at Evansville on the Ohio River during bad spells but he still had to use carbon for algae tastes.

Prof. Don E. Bloodgood was toastmaster at the dinner Wednesday night. Wrestling coach C. C. Reeck and two of his Big Ten champion wrestlers demonstrated the techniques used in the college sport but refused

(*Continued on page 90*)

***Loose-Leaf* BINDERS**

for A.W.W.A. Standards

Price $2.50

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500 Fifth Ave. New York 18, N.Y.

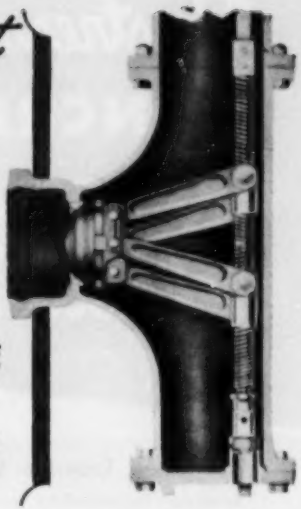
Sturdily bound in blue canvas with lettered backbone, the binder has durable metal hinges, capacious 1½-in. rings and eight blank separator cards with projecting tabs. All A.W.W.A. specifications will be provided punched to fit the binder as soon as the older stocks have been exhausted.

No Sir.... that

RENSSELAER MAIN VALVE

can't open by barrel breakage

IT'S MECHANICALLY LOCKED SHUT



HERE'S another feature of the famous Rensselaer Hydrant—NO FLOODING if barrel is broken. The main valve is MECHANICALLY LOCKED shut by steel forgings bearing solidly against the case. Valve seats stay tight—won't leak or scar. This Hydrant can't open unleas the stem is rotated.

What's more, if the standpipe is broken off, the ground line flange makes replacement quick and easy—no pavement breaking, no digging.

Yes, this Rensselaer Hydrant is a first-class investment. All working parts lift out easily, quickly. No water hammer. Drains fast without clogging. Solid bronze gives long life to vital parts. In short, SOUND DESIGN, a sound buy, proven by thousands in service making good the Rensselaer reputation. See a Rensselaer Representative for details—just call our nearest office.

THE FAMOUS RENSSELAER COREY HYDRANT

See how....

THE FLANGE AT GROUND LINE ELIMINATES DIGGING UP

7

LEADERSHIP FOR OVER 65 YEARS

RENSSELAER VALVE COMPANY

Hydrants • Gate Valves • Square Bottom Valves
Check Valves • Tapping Sleeves and Valves • Air Release Valves

TROY, NEW YORK

Division of Neptune Meter Company

Atlanta, Bala-Cynwyd, Pa., Chicago, Dallas, Denver, Haverhill, Mass., Hornell, N. Y., Kansas City, Los Angeles, Memphis, Oklahoma City, Pittsburgh, San Francisco, Seattle

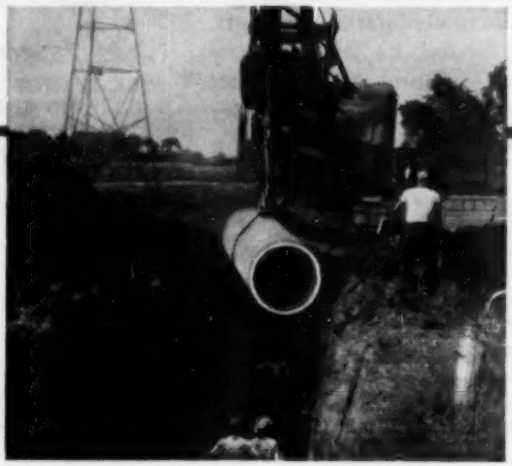
Prestressing CONCRETE and STEEL PRESSURE PIPE an Elastic Structure

Prestressed Concrete Steel-Cylinder Pipe

Longest trouble-free service at lowest cost

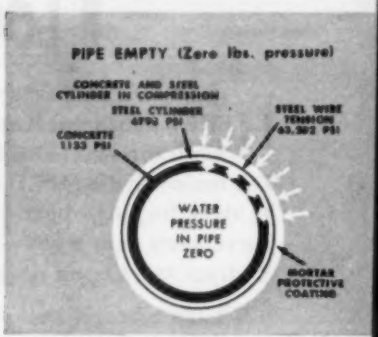
Prestressed Pipe combines the strength of steel, the protection of concrete and the flexibility of a rubber joint to provide *a combination of advantages found in no other pipe.* It has a life expectancy of 100 years and more, highest carrying capacity, and water tightness under highest pressures. Its great structural strength provides safety from sudden and complete failure. It is easy to lay, easy to tap, and provides great flexibility in design.

Prestressed Concrete Steel-Cylinder Pipe is available in 16 foot lengths and in the following diameters: 16", 20", 24", 30", 36", 42", 48" and larger.



Installing Price Brothers Prestressed Pipe on the 80-mile Saginaw-Midland project, one of America's longest high-pressure water supply pipe lines. Pull shovel digs trench and lays pipe.

Structural Changes That C



At zero internal pressure, the concrete core and steel cylinder are compressed by the steel wire wrapping.

Price Brothers engineers know pipe line design and construction problems. We will be glad to estimate pipe and installation costs, without obligation.

Prestressed Concrete Steel-Cylinder Pipe consists of a structural core of concrete, a water-tight steel cylinder, a wrapping of steel wire, and a protective coating of cement mortar.

The pipe is prestressed by wrapping the high-tensile wire around the steel cylinder and cured concrete core. The wire is wound under tension and compresses both the cylinder and the concrete core.

As water pressure inside the pipe increases, this compression decreases. The steel cylinder and concrete core go into tension only after the compression is relieved. *At normal operating pressure,* the concrete core and steel cylinder are *still under compression.*

Because of this design, the concrete core, the steel cylinder and the wire wrapping continue to act as *an elastic structure,* in spite of their different characteristics.

ur When Pressure Is Increased In A Typical Class 150 30″ Pipe

(Similar conditions exist in pipe 16″ in diameter and larger)

WORKING PRESSURE (150 lbs.)
CONCRETE AND STEEL CYLINDER AT ZERO COMPRESSION (162 lbs.)
ELASTIC LIMITS OF STEEL WIRE AND STEEL CYLINDER (337.5 lbs.)
STEEL CYLINDER ZERO PSI
STEEL WIRE TENSION 75,000 PSI
CONCRETE ZERO PSI
WATER PRESSURE 162 PSI
STEEL WIRE TENSION 150,000 PSI
WATER PRESSURE 337.5 PSI

working pressure of 150 psi, the compression in both the steel cylinder and concrete core is partially relieved by the internal pressure of the water, but still remain in compression.

With internal pressure at 162 psi, the compressive stress in the concrete core and steel cylinder is zero. They go into tension only after pressure increases past this point.

As internal pressure is increased further, tensile stress of steel cylinder and wire increase uniformly until they reach their elastic limits at 337.5 psi.

Send for these fact-packed booklets on Price Brothers Prestressed Concrete Steel-Cylinder Pipe.

Price Brothers Company

1753 EAST MONUMENT AVENUE, DAYTON 1, OHIO

Please send me information on Prestressed Pipe.

- ☐ Manufacturing and Prestressing
- ☐ Tapping under Pressure
- ☐ AWWA Specification No. 78.2-T

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ORGANIZATION_____

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(Continued from page 86)

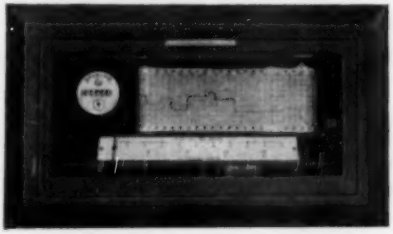
to be drawn into an argument on the television exhibitions which are billed as wrestling. By very witty and somewhat logical tactics Prof. W. P. Allyn, of Indiana State Teachers College, proved that "The Human Head is a Colossal Hatrack."

On Thursday Ross Teckemeyer outlined the State Pension Plan which can be used for municipal water works employees. Paul E. Congdon compared the state plan to a local plan in practice at Fort Wayne, and H. C. Powers told of experiences with the state plan at Tell City where labor leaders wanted nothing to do with any plan which did not come from Washington. Vice-Chairman Jack Gordon reviewed those parts of the Southwest Section Committee Report on "Licensing of Water Works Employees" which appeared applicable to Indiana. B. A. Poole described past efforts of the State Board of Health along these lines and indicated the type of law he thought the Board would back. L. A. Geupel suggested a Control Board for water works men similar to the Engineering Registration Board.

At the noon luncheon in the Union Ball Room Director E. F. Kinney presented Dr. A. P. Black, national President, who spoke briefly on Asso-

(Continued on page 92)

SPARLING MAIN-LINE METERS



When you install this Sparling Indicator-Totalizer-Recorder where you can keep your eye on it, you KNOW what is going through the Sparling-metered distribution or pump line, with records of operations up to 60 days!

Bulletin 310 comes on request

Sparling Meter Company
LOS ANGELES - CHICAGO - CINCINNATI
NEW YORK - BOSTON
SEATTLE - DALLAS

Are you **MOVING ?**

Please advise A.W.W.A. promptly of any change in your mailing address. Leaving a forwarding address at your old post office is not enough, because postal regulations require periodicals to be returned to the sender if not claimed at the original destination.

Prompt notification will keep your Journals and other communications coming to you without annoying delays and lapses.

American Water Works Assn., Inc.
500 Fifth Ave. New York 18, N.Y.

No question about it; the most popular beverage of all is good drinking water—water that tastes right, smells right and looks right.

And there's no reason for water not to be "right." Where Welsbach Ozonating equipment is used, consumers know the pleasure of drinking water free from disagreeable chlorinous odors, offensive "medicinal" tastes and objectionable color.

The biggest Ozone installation in the world (serving the Belmont filtration area in Philadelphia) proves that through Welsbach, cities can get the most efficient type of water treatment at a cost that's kind to the taxpayers.

• • •

Everybody wants improved drinking water—and all communities can now have it. Water technicians, city officials and consulting engineers particularly will be interested in the Welsbach-Ozone story. They are invited to write about their water difficulties to The Welsbach Corporation. A frank, factual analysis will be made—at no cost or obligation. Also ask for, "Are Bathless Thursdays Really Necessary?", the picture story booklet about the Welsbach-Ozone process and equipment.

THE WELSBACH CORPORATION

Ozone Processes Division

1500 Walnut Street, Philadelphia 2, Pennsylvania

(Continued from page 90)

ciation affairs and presented the Fuller Award to John L. Ford "for constructive leadership in Section and Association affairs."

Discussing the "Elements of Water Rates from an Accounting Viewpoint," Carl Cecil, chief accountant of the Public Service Commission of Indiana, stated that depreciation is the largest single cost of any water works whether it is making a profit or not. Comments from Edgar C. Kruse, Auditor of the Fort Wayne City Utilities, and Max Stearns, Manager of the Kokomo Water Works Company, both of whom have recently gone to the commission for rate adjustments, emphasized the need for accurate records on costs. The commission cannot set rates on guesses. Most water works managers who sweat when a cashier is fifty cents off her balance, or when the petty cash is short one dollar, never give a thought to the thousands of dollars they lose in false depreciation. Questions from the floor and answers by the "experts" carried this paper and the following one on "Insurance—Public Liability and Workmen's Compensation" by Harry Von Burg well toward the close of the session. Debate was limited by the presiding officer, Harvey J. Kulin, to permit G. J. Manahan to show his film on the "Insertion of Valves Under Pressure."

(Continued on page 94)

LIMITORQUE ..for SAFE, DEPENDABLE operation of valves

A LimiTorque installation at a mid-west pumping station.

Limitorque operates by the "push of a button" from either remote or nearby control panel . . . prevents damage to stem, seat, disc, gate or plug, because Torque Seating Switch limits the torque and thereby shuts off the motor before trouble can occur . . . actuated by any available power source . . . fits all types of valves. LimiTorque may be obtained through valve manufacturers.

Write for catalog on your Business Letterhead, please.

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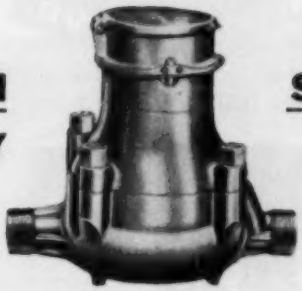
ACCURATE

FROM MAXIMUM CAPACITY



TO SMALLEST FLOWS

Torrent or trickle—CALMET *accurately* records the water used by your consumers. CALMET'S slower moving oscillating piston, precision balanced and practically floating between the velvet-smooth surfaces of a large capacity measuring chamber, is *super-sensitive* to *every* flow of water. It actually requires only 256 movements of the piston to measure a cubic foot of water in the 5/8" meter. Because the slower moving parts hold friction and wear to a minimum, this high degree of accuracy is maintained over longer periods, assuring *more income* at less upkeep.

Standardize TODAY on the meter of TOMORROW—CALMET!

• **SALES REPRESENTATIVES**
Write for complete details of the CALMET franchise in your territory.

CALMET WATER METERS

MADE BY WELL MACHINERY & SUPPLY CO. INC. – FORT WORTH, TEXAS

(*Continued from page 92*)

At the annual banquet Musical Varieties by university students filled the interim between a hearty meal and a thought-provoking talk on our foreign policy by Walter O. Forster, assistant professor of history and government at Purdue.

The Friday morning session was slanted toward maintenance men and the operators whose main problem is the distribution system. M. P. Susanke, engineer for the Indiana Rating Bureau (fire insurance), talking

George G. Fassnacht, Secretary-Treasurer with then President Black and Section Past Chairman Marshall P. Crabill, Vice-Chairman Charles H. Bechert and Chairman Jack Gordon.

A trio of Indiana Section notables includes Clyde E. Williams, Past Chairman; John L. Ford, Fuller Awardee; and Paul J. Kleiser, who presented a paper on the importance of distribution system records.

about "Defects of Your Water Distribution System," said that a distribution grid must be designed to keep pressures on sprinkler systems while pumpers are pulling from the mains. Any pressure variation on the system between night and day or over a period of heavy lawn sprinkling is a sign of trouble. Clyde E. Williams and Paul J. Kleiser, consulting engineers, stressed the need for records of underground property. The observing

(*Continued on page 96*)

HOW WATER WORKS WORK

may be learned from a proper interpretation of "A Survey of Operating Data for Water Works in 1945"—a comprehensive tabulation of rates, income, costs and other vital statistics for 462 utilities serving communities of over 10,000 population. Reprinted from the February 1948 JOURNAL.

96 pages 50 cents

American Water Works Association
500 Fifth Avenue New York 18, N. Y.

Survival and Retirement Experience With Water Works Facilities

Containing vital information on the actual life of mains, valves, meters, services and other facilities in 26 cities, together with 56 pages of summary tables that condense the data for easier interpretation.

576 pages $3.00

American Water Works Association
500 Fifth Avenue New York 18, N. Y.

Throw a wet blanket

HIGH COSTS!

SEE THESE BENEFITS:

- Short Detention Time
- Lowest Chemical Requirements
- Absence of Settling
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- Low Turbidity
- Lengthened Filter Runs

The Sludge Blanket in the Permutit® Precipitator acts as a filter . . . SAVES YOUR EXPENSIVE CHEMICALS!

The positively agitated uniform sludge filter in the Permutit Precipitator will save you up to 50% in space and 75% in time of treatment too!

The Permutit Precipitator offers you the newest and most efficient means of removing impurities from your water. It does this by precipitation, adsorption, settling, and upward filtration. Write for full details to the Permutit Company, Dept. JA-7, 330 West 42nd St., New York 18, N. Y., or to the Permutit Co. of Canada, Ltd., 6975 Jeanne Mance, Montreal.

FOR 37 YEARS
WATER CONDITIONING HEADQUARTERS

Permutit

(Continued from page 94)

operator who makes immediate report of deviations from normal conditions can often forestall serious trouble. In fact, the non-observing operator should be classed as a defect when rating a system.

Predicating his paper on the fact that as public tolerance toward interruptions in service disappears, efficient maintenance becomes more important, H. W. Niemeyer, superintendent of distribution at Indianapolis, went on to give detailed instructions for a practical and effective maintenance program. Glen Garman gave some practical hints on maintenance, claiming that frequent operation of valves with a nearby hydrant running was probably the most effective single thing you could do. "No valve ever wore out with use," he claimed, "but many have been damaged or destroyed by standing idle."

At the business meeting committee reports were heard. Membership was increased by approximately 60 during the year. The Nominating Committee Report was accepted and the following officers were installed before adjournment: Chairman, Jack Gordon; Vice-Chairman, Charles H. Bechert; Secretary-Treasurer, George G. Fassnacht.

GEORGE G. FASSNACHT
Secretary-Treasurer

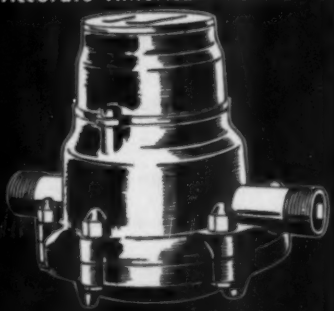
It Is Easy To Switch Cigarettes But Not Fire Hydrants

A fire hydrant installation must serve for years. Don't make your decision until you get full specifications of the Kupferle line . . . the Fire Hydrant that has served with distinction for more than a half century.

JOHN C. KUPFERLE FOUNDRY CO.
ST. LOUIS

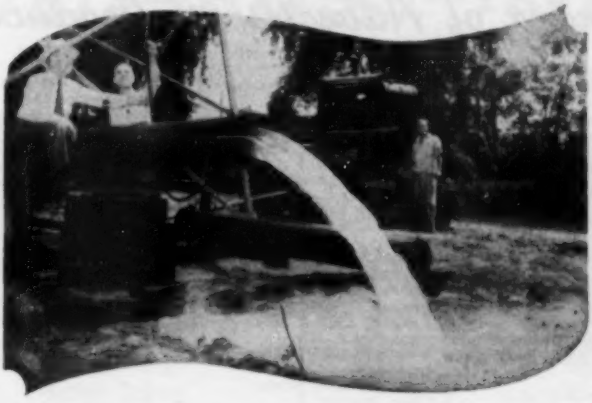
KUPFERLE
FIRE HYDRANTS

Earn FULL REVENUE with Accurate American Meters



The superior accuracy built into Buffalo AMERICAN Meters enables you to earn full revenue from metered water in your system. Metered water is "fair to all." Write for details.

BUFFALO METER COMPANY
2914 Main Street
Buffalo 14, New York



What's the Value of

HIGH PRECISION IN MANUFACTURE

Precision is a very important requirement by the Layne organization. It is the only feature that can adequately support skillful engineering and top quality materials. The results of high precision are,—smoother operation, greater quantities of water and lower upkeep cost.

All well water systems are complicated under ground construction projects that require much more than ordinary skill. Fortunately Layne has an abundance of real "know how" that came from years of world wide experience. When they plan a well water system, furnish the pumps and do the work complete, you get a thoroughly dependable job that provides years and years of fine service.

If your plans call for more water in 1950, why not call in Layne first, and obtain the value of their proved "know how" and the satisfaction of dealing with a firm of highest reputation. For catalogs, bulletins etc., address

LAYNE & BOWLER, INC.

LAYNE

General Offices,
Memphis 8, Tenn.

WELL WATER SYSTEMS

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Morse Bros. Mchy. Co.
Worthington Pump & Mach. Corp.

Air-Lift Pumping Systems:
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Permutit Co.
Proportioneers, Inc.
Ross Valve Mfg. Co.
Simplex Valve & Meter Co.
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Chemical Scale Removal Services:
Dowell Incorporated

Chemists and Engineers:
(See Prof. Services, pp. 24–27)

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Everson Mfg. Corp.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.

Chlorine Comparators:
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Warren Foundry & Pipe Corp.

Clarifiers:
American Well Works
Chain Belt Co.
Cochrane Corp.
Dorr Co.
Graver Water Conditioning Co.
Infilco, Inc.
Permutit Co.
Walker Process Equipment, Inc.

Cleaning Water Mains:
Flexible Underground Pipe Cleaning Co.
National Water Main Cleaning Co.

Cocks, Curb and Corporation:
Hays Mfg. Co.
James Jones Co.
A. P. Smith Mfg. Co.

Compressors, Portable:
Worthington Pump & Mach. Corp.

Condensers:
United States Pipe & Foundry Co.

Contractors, Water Supply:
Boyce Co., Inc.
Layne & Bowler, Inc.

Controllers, Liquid Level, Rate of Flow:
Builders-Providence, Inc.
Infilco, Inc.
Simplex Valve & Meter Co.
R. W. Sparling

Copper Sheets:
American Brass Co.

Copper Sulfate:
General Chemical Div.
Tennessee Corp.

Corrosion Control:
Calgon, Inc.
Dearborn Chemical Co.

Couplings, Flexible:
DeLaval Steam Turbine Co.
Dresser Mfg. Div.
Philadelphia Gear Works, Inc.

Customer Bill Analysis:
Recording & Statistical Corp.

Diaphragms, Pump:
Dorr Co.
Morse Bros. Mchy. Co.
Proportioneers, Inc.

Engines, Hydraulic:
Ross Valve Mfg. Co.

Engineers and Chemists:
(See Prof. Services, pp. 24–27)

Feedwater Treatment:
Calgon, Inc.
Cochrane Corp.
Dearborn Chemical Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco, Inc.

Ferric Sulfate:
Tennessee Corp.

Filter Materials:
Johns-Manville Corp.
Infilco, Inc.
Northern Gravel Co.

Filters, incl. Feedwater:
Cochrane Corp.
Dorr Co.
Everson Mfg. Corp.
Infilco, Inc.
Morse Bros. Mchy. Co.
Permutit Co.
Roberts Filter Mfg. Co.
Ross Valve Mfg. Co.
Walker Process Equipment, Inc.

Filtration Plant Equipment:
Builders-Providence, Inc.
Chain Belt Co.
Cochrane Corp.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco, Inc.
Omega Machine Co. (Div., Builders Iron Fdry.)
Roberts Filter Mfg. Co.
Stuart Corp.
Walker Process Equipment, Inc.
Welsbach Corp., Ozone Processes Div.

Fittings, Copper Pipe:
Dresser Mfg. Div.
M. Greenberg's Sons
Hays Mfg. Co.
James Jones Co.

Fittings, Tees, Ells, etc.:
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Dresser Mfg. Div.
James Jones Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Flocculating Equipment:
Chain Belt Co.
Cochrane Corp.
Dorr Co.
Infilco, Inc.
Stuart Corp.
Walker Process Equipment, Inc.

Fluoride, Sodium:
Aluminum Co. of America, Chemicals Div.

Furnaces:
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Furnaces, Joint Compound:
Northrop & Co., Inc.

Gages, Liquid Level:
Builders-Providence, Inc.
Infilco, Inc.
Simplex Valve & Meter Co.

Gages, Loss of Head, Rate of Flow, Sand Expansion:
Builders-Providence, Inc.
Infilco, Inc.
Northrop & Co., Inc.
Simplex Valve & Meter Co.
R. W. Sparling

Gasholders:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Gaskets, Rubber Packing:
Northrop & Co., Inc.

1879—ROSS—1879

Automatic Valves

ALTITUDE VALVE

Controls elevation of water in tanks, basins and reservoirs

1. Single Acting
2. Double Acting

Maintains safe operating pressures for conduits, distribution and pump discharge

SURGE-RELIEF VALVE

REDUCING VALVE

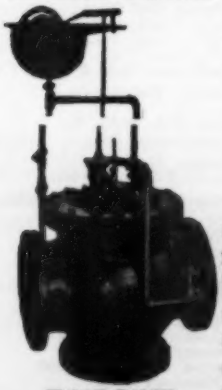
Maintains desired discharge pressure regardless of change in rate of flow

Regulates pressure in gravity and pump systems; between reservoirs and zones of different pressures, etc.

A self contained unit with three or more automatic controls

COMBINATION VALVE

Combination automatic control both directions through the valve.



FLOAT VALVE

Maintains levels in tank, reservoir or basin

1. As direct acting
2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

Electric remote control—solenoid or motor can be furnished

REMOTE CONTROL VALVE

Adapted for use as primary or secondary control on any of the hydraulically controlled or operated valves.

Packing Replacements for all Ross Valves Through Top of Valve

ROSS VALVE MFG. CO., INC., P. O. BOX 593, TROY, N. Y.

Gates, Shear and Sluice:
Armco Drainage & Metal Products, Inc.
Morse Bros. Mchy. Co.
R. D. Wood Co.

Gears, Speed Reducing:
DeLaval Steam Turbine Co.
Philadelphia Gear Works, Inc.

Glass Standards—Colorimetric Analysis Equipment:
Hellige, Inc.
Klett Mfg. Co.
Wallace & Tiernan Co., Inc.

Goosenecks (with or without Corporation Stops):
Hays Mfg. Co.
James Jones Co.
A. P. Smith Mfg. Co.

Hydrants:
James B. Clow & Sons
M. Greenberg's Sons
James Jones Co.
Kennedy Valve Mfg. Co.
John C. Kupferle Foundry Co.
Ludlow Valve Mfg. Co.
M & H Valve & Fittings Co.
A. P. Smith Mfg. Co.
Kenneleaer Valve Co.
Ross Valve Mfg. Co.
R. D. Wood Co.

Hydrogen Ion Equipment:
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Ion Exchange Materials:
Hungerford & Terry, Inc.
Infilco, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Rohm & Haas Co.

Iron Removal Plants:
American Well Works
Chain Belt Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.
Welsbach Corp., Ozone Processes Div.

Jointing Materials:
Atlas Mineral Products Co.
Michael Hayman & Co., Inc.
Hydraulic Development Corp.
Leadite Co., Inc.
Northrop & Co., Inc.

Joints, Mechanical, Pipe:
Carson-Cadillac Co.
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
Dresser Mfg. Div.
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Leak Detectors:
Jos. G. Pollard Co., Inc.

Lime Slakers and Feeders:
Dorr Co.
Infilco, Inc.
Omega Machine Co. (Div., Builders Iron Fdry.)

Magnesium Anodes (Corrosion Control):
Dowell Incorporated

Manometers, Rate of Flow:
Builders-Providence, Inc.

Meter Boxes:
Art Concrete Works
Ford Meter Box Co.
Pittsburgh Equitable Meter Div.

Meter Couplings and Yokes:
Badger Meter Mfg. Co.
Dresser Mfg. Div.
Ford Meter Box Co.
Hays Mfg. Co.
Hersey Mfg. Co.
James Jones Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
A. P. Smith Mfg. Co.
Worthington-Gamon Meter Co.

Meter Reading and Record Books:
Badger Meter Mfg. Co.

Meter Testers:
Badger Meter Mfg. Co.
Ford Meter Box Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.

Meters, Domestic:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
A. P. Smith Mfg. Co.
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Meters, Filtration Plant, Pumping Station, Transmission Line:
Builders-Providence, Inc.
Infilco, Inc.
Simplex Valve & Meter Co.
R. W. Sparling

Meters, Industrial, Commercial:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Builders-Providence, Inc.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Simplex Valve & Meter Co.
A. P. Smith Mfg. Co.
R. W. Sparling
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Mixing Equipment:
Chain Belt Co.
Infilco, Inc.
Walker Process Equipment, Inc.

Ozonation Equipment:
Welsbach Corp., Ozone Processes Div.

Pipe, Asbestos-Cement:
Johns-Manville Corp.
Keasbey & Mattison Co.

Pipe, Brass:
American Brass Co.

Pipe, Cast Iron (and Fittings):
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Pipe, Cement Lined:
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Pipe Coatings and Linings:
The Barrett Div.
Cast Iron Pipe Research Assn.
Centriline Corp.
Dearborn Chemical Co.
Koppers Co., Inc.
Warren Foundry & Pipe Corp.

Pipe, Concrete:
American Pipe & Construction Co.
Lock Joint Pipe Co.
Price Bros. Co.

Pipe, Copper:
American Brass Co.

Pipe Cutting Machines:
Ellis & Ford Mfg. Co.
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Pipe Jointing Materials: see **Jointing Materials**

Pipe Locators:
Jos. G. Pollard Co., Inc.

Pipe, Plastic:
Carter Products Corp.

Pipe, Steel:
Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co.

Pipelines, Submerged:
Boyce Co., Inc.

Plugs, Removable:
James B. Clow & Sons
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.
Warren Foundry & Pipe Corp.

Potentiometers:
Hellige, Inc.

Pressure Regulators:
Ross Valve Mfg. Co.

Pumps, Boiler Feed:
DeLaval Steam Turbine Co.
Peerless Pump Div., Food Machinery Corp.

Pumps, Centrifugal:
American Well Works
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Morse Bros. Mchy. Co.
Peerless Pump Div., Food Machinery Corp.

Pumps, Chemical Feed:
Infilco, Inc.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.

Pumps, Deep Well:
American Well Works
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery Corp.
Worthington Pump & Mach. Corp.

Pumps, Diaphragm:
Dorr Co.
Morse Bros. Mchy. Co.
Proportioneers, Inc.

Pumps, Hydrant:
Jos. G. Pollard Co., Inc.

Pumps, Hydraulic Booster:
Ross Valve Mfg. Co.

Pumps, Sewage:
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Peerless Pump Div., Food Machinery Corp.

Pumps, Sump:
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Peerless Pump Div., Food Machinery Corp.

Pumps, Turbine:
DeLaval Steam Turbine Co.
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery Corp.
Worthington Pump & Mach. Corp.

WORTHINGTON-GAMON

WATCH DOG

WATER METERS

The meter used by thousands of municipalities in the U. S.

"Watch Dog" models . . . made in standard capacities from 20 g.p.m. up: frost-proof and split case in household sizes. Disc, turbine, or compound type.

SURE TO MEET YOUR SPECIFICATIONS FOR ACCURACY, LOW MAINTENANCE, LONG LIFE.

Before you invest in water meters, get acquainted with the design and performance advantages which make Worthington-Gamon Watch Dog Water Meters first choice of so many municipalities and private water companies in the United States.

WORTHINGTON-GAMON METER CO.

296 South Street, Newark 5, New Jersey

SUBSIDIARY OF

WORTHINGTON

WORTHINGTON PUMP AND MACHINERY CORPORATION

Recorders, Gas Density, CO_2, NH_3, SO_2, etc.:
Permutit Co.
Wallace & Tiernan Co., Inc.

Recording Instruments:
Builders-Providence, Inc.
Infilco, Inc.
R. W. Sparling
Wallace & Tiernan Co., Inc.

Reservoirs, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Sand Expansion Gages: see Gages

Sleeves: see Clamps

Sleeves and Valves, Tapping:
James B. Clow & Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Sludge Blanket Equipment:
Cochrane Corp.
Permutit Co.

Soda Ash:
Solvay Sales Div.

Sodium Hexametaphosphate:
Calgon, Inc.

Softeners:
Cochrane Corp.
Dearborn Chemical Co.
Dorr Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Softening Chemicals and Compounds:
Calgon, Inc.
Infilco, Inc.
Permutit Co.
Tennessee Corp.

Standpipes, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Steel Plate Construction:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Storage Tanks: see Tanks

Strainers, Suction:
M. Greenberg's Sons
R. D. Wood Co.

Surface Wash Equipment:
Permutit Co.
Stuart Corp.

Swimming Pool Sterilization:
Everson Mfg. Corp.
Omega Machine Co. (Div., Builders Iron Fdry.)
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Tanks, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Tapping Machines:
Hays Mfg. Co.
A. P. Smith Mfg. Co.

Taste and Odor Removal:
Cochrane Corp.
Industrial Chemical Sales Div.
Infilco, Inc.
Proportioneers, Inc.
Walker Process Equipment, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Telemeters, Level, Pump Control, Rate of Flow, Gate Position, etc.:
Builders-Providence, Inc.

Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Turbines, Steam:
DeLaval Steam Turbine Co.

Turbines, Water:
DeLaval Steam Turbine Co.

Valve Boxes:
Central Foundry Co.
James B. Clow & Sons
Ford Meter Box Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valve Inserting Machines:
A. P. Smith Mfg. Co.

Valves, Altitude:
Ross Valve Mfg. Co., Inc.

Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
James B. Clow & Sons
M. Greenberg's Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
R. D. Wood Co.

Valves, Detector Check:
Hersey Mfg. Co.

Valves, Electrically Operated:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Valves, Float:
Ross Valve Mfg. Co., Inc.

Valves, Gate:
Dresser Mfg. Div.
James Jones Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Hydraulically Operated:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Large Diameter:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Regulating:
Ross Valve Mfg. Co.

Valves, Swing Check:
James B. Clow & Sons
M. Greenberg's Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Waterproofing
Dearborn Chemical Co.
Inertol Co., Inc.

Water Softening Plants: see Softeners

Water Supply Contractors:
Layne & Bowler, Inc.

Water Testing Apparatus:
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Water Treatment Plants:
American Well Works
Chain Belt Co.
Chicago Bridge & Iron Co.
Dearborn Chemical Co.
Dorr Co.
Everson Mfg. Corp.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco, Inc.
Pittsburgh-Des Moines Steel Co.
Roberts Filter Mfg. Co.
Stuart Corp.
Walker Process Equipment, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

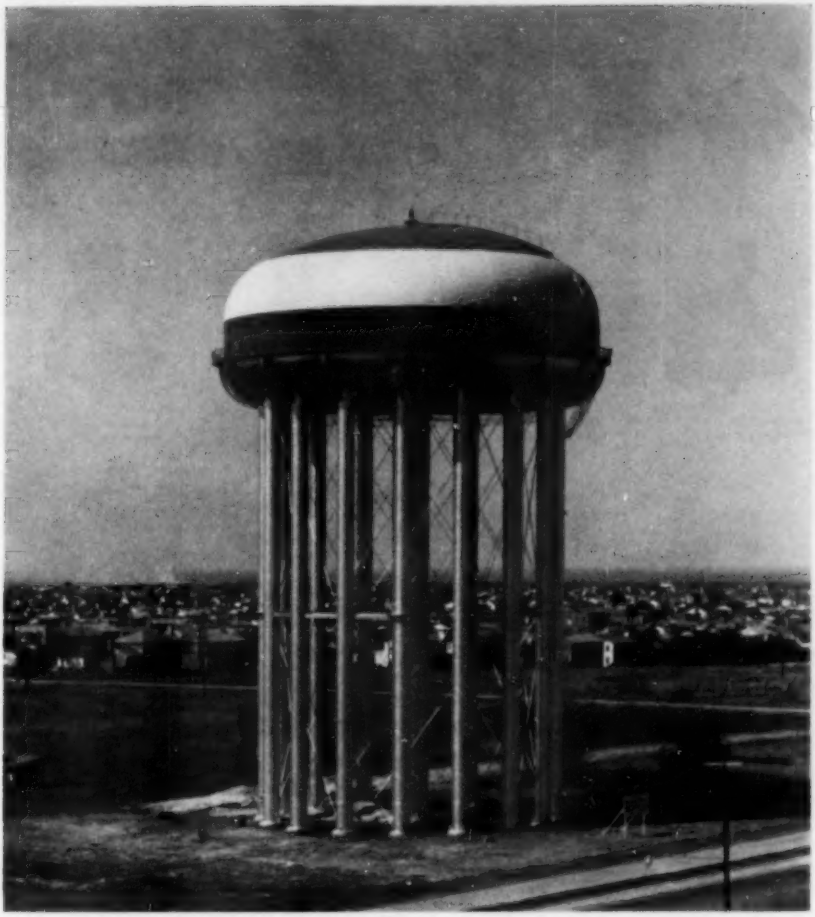
Well Acidizing:
Dowell Incorporated

Well Drilling Contractors:
Layne & Bowler, Inc.

Wrenches, Ratchet:
Dresser Mfg. Div.

Zeolite: see Ion Exchange Materials

A complete Buyers' Guide to all water works products and services offered by A.W.W.A. Associate Members appears in the 1948 Membership Directory.



Radial-Cone Tank at Dallas

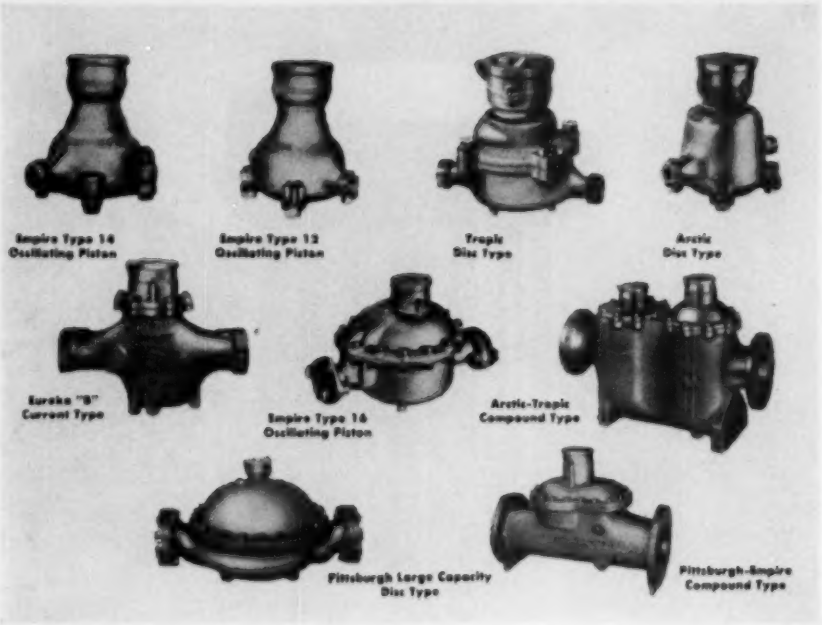
The 2,000,000-gal. radial-cone elevated tank shown above was recently installed by the Dallas Park Cities Water District No. 2 to provide gravity water pressure in its distribution system serving the suburbs of Highland Park and University Park. The structure, which is 117 ft. to the bottom, has a range in head of 35 ft. between the upper and lower water levels. Write our nearest office for information and estimating figures on elevated steel tanks of welded construction.

CHICAGO BRIDGE & IRON COMPANY

BIRMINGHAM CHICAGO TULSA BOSTON SALT LAKE CITY
PHILADELPHIA NEW YORK DETROIT SEATTLE CLEVELAND
SAN FRANCISCO HOUSTON ATLANTA HAVANA LOS ANGELES

'MADE TO MEASURE'

WITH YOU IN MIND


Empire Type 14 Oscillating Piston
Empire Type 12 Oscillating Piston
Tropic Disc Type
Arctic Disc Type
Eureka "B" Current Type
Empire Type 16 Oscillating Piston
Arctic-Tropic Compound Type
Pittsburgh Large Capacity Disc Type
Pittsburgh-Empire Compound Type

Custom Tailored FOR YOUR WATER SYSTEM

To put an end to water waste—to increase revenue—to keep down meter maintenance costs you need the *right* type of meter on every job. Custom fitting the proper meter to the setting is an important part of Rockwell service. Since we alone make all types of meters our recommendations can be made without prejudice and in your best interests. For this type of sound advice or for help with any measurement problem you may have, write the nearest Rockwell District Office.

Pittsburgh Equitable Meter Division

ROCKWELL MANUFACTURING COMPANY

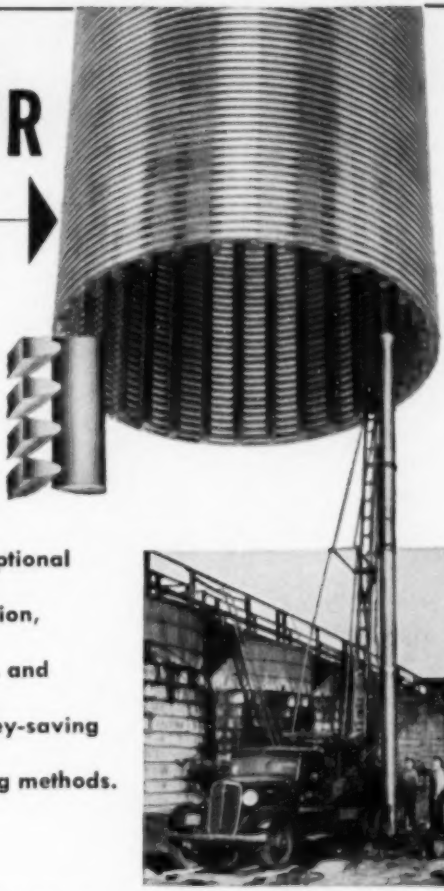
Pittsburgh 8, Pa.

Atlanta Boston Chicago Columbus Houston Kansas City
Los Angeles New York Pittsburgh San Francisco Seattle Tulsa

PITTSBURGH WATER METERS

EVERDUR

for well screens



Famous for exceptional resistance to corrosion, high strength, and adaptability to money-saving fabricating methods.

Johnson Well Screen, *16 in. O.D. by 35 ft. long, being lowered into well casing.*

UPPER INSET—*Cross-sections, slightly enlarged, show Everdur rod and wire members. Welds are made at a rate of 15 to 28 per second.*

For over 20 years, Everdur* has been standard material for well screens with Edward E. Johnson, St. Paul, Minn., because Everdur stubbornly resists corrosion and fatigue, has unusual strength and can be assembled by automatic resistance welding. Everdur Alloys can be cast, machined, stamped, pressed, forged, welded, and are available in sheets, plates, bars, rods, angles, tees, "I" beams or casting ingots. For more data write The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5014SA

Where corrosion resistance counts—consider Everdur

ANACONDA®

COPPER-SILICON ALLOYS

*Reg. U. S. Pat. Off.

LEADITE

Jointed for . . . Permanence with LEADITE

Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains MUST BE GOOD,—MUST BE DEPENDABLE,—and that is just why so many Engineers, Water Works Men and Contractors aim to PLAY ABSOLUTELY SAFE, by specifying and using LEADITE.

Time has proven that LEADITE not only makes a tight durable joint,—but that it improves with age.

The pioneer self-caulking material for c. i. pipe.
Tested and used for over 40 years.
Saves at least 75%

THE LEADITE COMPANY
Girard Trust Co. Bldg. Philadelphia, Pa.

No Caulking